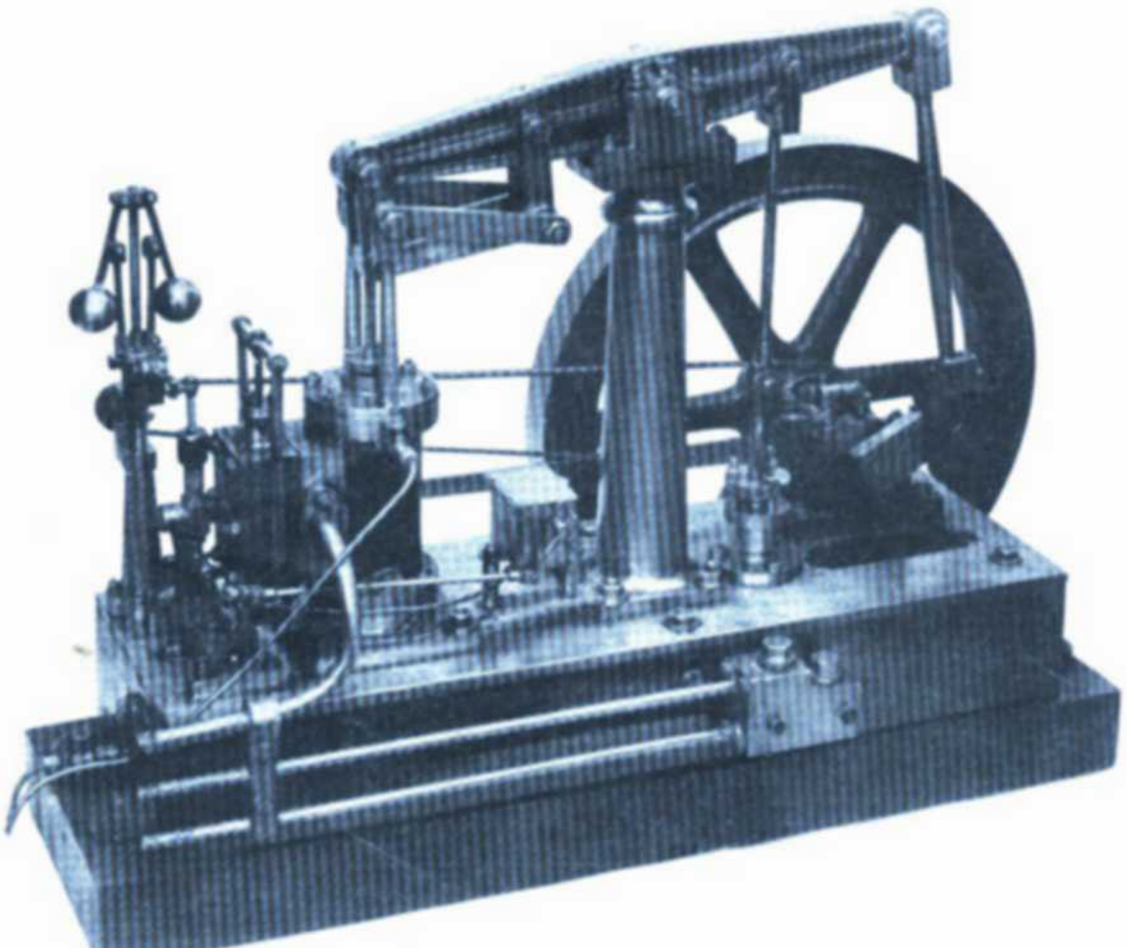
THE MODEL ENGINEER



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THE MODEL ENGINEER

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Our Cover Picture

The model beam engine illustrated here was built by Mr. C. J. Hutchings, of Surbiton, and is not claimed to be an exact copy of any particular prototype, but its general features are fairly true to type. The cylinder is of gunmetal, $1\frac{1}{2}$-in. bore by 3-in. stroke, and the beam is 11-in. long in cast-iron. An overhung crankshaft $\frac{5}{8}$-in. diameter is fitted. The flywheel is 10-in. diameter. It is mounted on a box bed 16-in. long by 6-in. wide, built up with side and end plates of 2-in. x $\frac{1}{4}$-in. mild-steel.

The governor is very sensitive, and keeps the engine running at a constant speed of about 180 revs. per minute. A feed pump is fitted, with the valve box located on the outside of the bed, and rustless-steel ball valves. A mechanical lubricator of the type described by "L.B.S.C." is fitted. All the patterns were home-made and were cast locally.

Mr. Hutchings is 78 years old, and states that the work occupied about 12 months, every minute of which was thoroughly enjoyed.

SMOKE RINGS

British Railways on Parade

IN CONNECTION with the International Railway Congress, held this year in London, the British Transport Commission arranged an exhibition of locomotives, rolling-stock, signalling and other equipment; it was originally planned to be open from the May 26th to 29th, but was extended to June 4th. We felt some regret that this show had not been either more widely advertised, or extended to a longer period, for here was a display which should have been available to a much wider public. Examples of the very latest steam, diesel and electric motive power; new standard rolling-stock for passenger and freight traffic; the latest types of apparatus for signalling and telecommunications; all kinds of machines for track-laying and maintenance, were displayed in one of the locomotive roundhouses at Willesden Junction, which had been specially and ingeniously converted into a fine exhibition hall, specially for this show.

It ought to be possible to arrange exhibitions of this kind more often, and in different parts of the country; they would more than justify their cost and the comparatively slight dislocation of railway routine that they would involve, if only because they offer a potent means of countering much of the ill-formed criticism to which the railways seem to be subjected today.

Locomotive Testing

WITH SO many first-class tracks now available for the running of small steam locomotives, we note that various "trials" are carried out at suitable opportunities. These trials seem to vary in style; a locomotive may be set to haul her driver round the complete circuit in the quickest time she can do it; or, she may be put to doing the same thing with the biggest load she can move; or, she may be started off with a view to finding out how far she can run non-stop.

As a further test, we would suggest that an engine be treated in the manner of full-size practice, by first planning a specified and definite time for covering a certain distance with varying loads, and then finding which engine can keep time, or improve upon it, with the least consumption of fuel.

The Maudslay Scholarship

THROUGH THE generosity of the Maudslay Society, the Junior Institution of Engineers is enabled to offer a scholarship, to be known as the "Maudslay Scholarship," to young engineers for the purpose of assisting them in their technical education and practical training. The scholarship this year has been doubled, and will be £300 for one year; candidates must not be more than 26 years of age and must be engineers, or training to be engineers, wholly or mainly interested in mechanical engineering. The closing date for entries for this award for each session is July 31st. Further information can be obtained from The Secretary, Junior Institution of Engineers, 39, Victoria Street, Westminster, S.W.1.

Twin Sisters

WE REGRET the delay which has occurred in publishing the concluding instalments of the articles describing the construction of the "Twin Sisters" locomotives and apologise for any inconvenience which this may have caused some of our readers.

Every effort is being made to obtain the final articles in this series from Mr. J. I. Austen-Walton, and as soon as they are received by us they will be published with the least possible delay.

A Locomotive Valve-Gear Model

By G. W. McArd

IN many engineering spheres, a model is made of every new machine, or part thereof, which is to be built, in order to test it thoroughly and make quite certain of successful operation before quantity production of the unit proceeds. The valve-gear on a new design of steam locomotive is an excellent example, since efficiency in the steam distribution in the cylinders entirely depends on the correct operation of the rods, links, eccentrics, etc., which go to form the valve-gear.

Some years ago, the writer, was privileged to design the model illustrated in these notes, and although he had long desired the inclusion of such a machine in his drawing office equipment, when it came to designing one from rock bottom the task bristled with difficulties. Accommodation must be made for trying out any gear for any size of engine, and as the leading dimension involved, viz.: that from the driving axle centre to the cylinder vertical centre-line may be anywhere between 5ft. 0 in. and 15 ft. 0 in., in round figures, some idea is afforded at the outset as to the nature of the problem. Allowance also must be made for the various types of gear used in locomotives throughout the world; in Britain alone there are at least five different gears in service, including Stephenson, Joy, Allan, Gooch and Walschaerts, and American engines have, among others, gears of the Baker and Southern types.

The illustration, Fig. 1, gives a good impression of the model as finally built, and is viewed from what is termed the driving axle end. The gear mounted thereon is of the Stephenson double-eccentric type with a quadrant serving for the well-known reversing shaft, and supporting the reversing link, which permits variation of cut-off in fore and back gear, by a pair of swinging links. At the other end of the model—the cylinder end—two slides are provided to deputise for the piston-rod and valve spindle, and these are operated by the main connecting-rod and valve-rod respectively.

Fig. 2 show the gear from the cylinder end, and illustrates clearly the suspended drawing-board with vertically operated pen for describing automatically the valve ellipses for the different cut-offs to be taken into consideration.

These models may be designed in two forms, either as wall models or mounted on pedestals for standing in the main area of the drawing-office. Where a sound and sub-

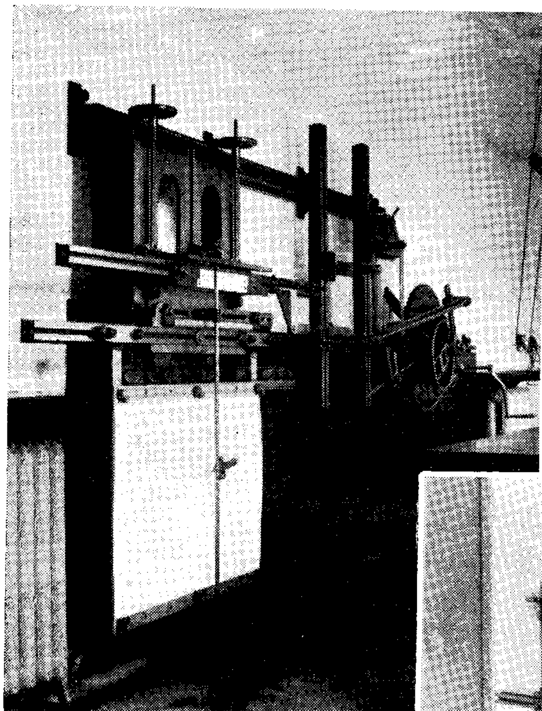
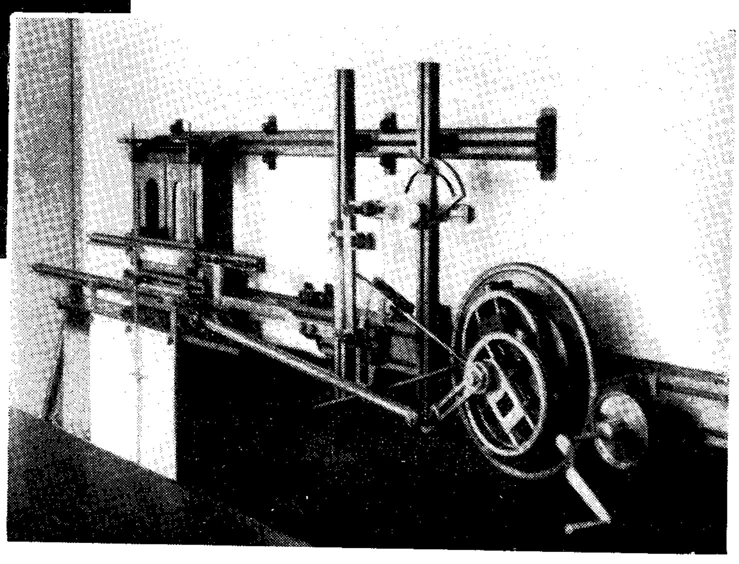


Fig. 2. Model as seen from cylinder end



Right: Fig. 1. Model as seen from driving axle end

stantial wall is available the first type is to be preferred, with foundation slides securely bolted thereto in a manner well able to carry the vertical members—adjustable longitudinally to suit any size of gear—and the cylinder plate. A close-up view of the latter is seen in Fig. 3, and has several items of interest. The guide in which the piston slide moves is fixed on the cylinder plate at the correct height above the driving axle, and any variation of the latter is made at that end. A pointer on the piston slide indicates the true centre of the piston head in relation to the centre of the driving axle, and this will show the precise end of the stroke when the crank is standing on its own dead centre. The duplex percentage scale at the cylinder end is graduated in rising values up to 100 per cent. from each end of the stroke, front and rear, to enable the percentage of stroke traversed to be read off instantly according to the direction of travel of the piston.

Variations

The height of the valve spindle above the cylinder centre-line varies on different engines, and accommodation must be provided (see Fig. 3) for raising or lowering the spindle and its guide; in the example shown, this is effected by handwheels on square-threaded screws after the securing bolts have been freed. To the slotted bar which serves as a valve spindle, a wooden strip is secured which carries a white card on which the vital edges of the slide or piston valve are drawn. Beneath this card another is secured to the fixed cylinder plate showing the port edges in the steamchest; as the crank is rotated, the observer can register with ease the various points of cut-off, release, compression and exhaust on his table of events, in terms of crank angle and percentage of stroke.

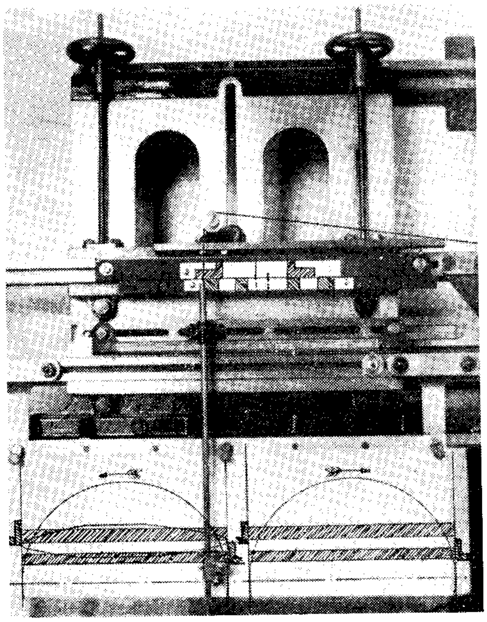
In Figs. 2 and 3 the drawing board is seen with a sheet of stout cartridge paper secured by six clamping-screws, three each along upper and lower edges. This sheet has a longitudinal motion only, derived from its attachment to the piston slide and, therefore, the rotation of the crank. The operating stylo pen seen is carried on a vertical spindle whose movement is derived from the valve spindle slide by means of a fine steel wire which passes over a fixed pulley. The combination of the two movements enables the true valve ellipse to be drawn for any degree of cut-off, and though the horizontal movement of the piston is constant, the vertical traverse of the pencil, i.e., the valve, is dependent on the point of cut-off, a big cut-off giving a "fat" diagram and per contra.

The Driving Axle

An interesting section of the model is the crank unit representing the driving axle, and is seen in Fig. 4. This member comprises a large toothed disc which, for ease of control, is driven by a pinion and crank. On the disc two series of graduations are seen, those on the outer rim enabling the one who drives the crank to call the angle for the different positions of the valve as required, and those nearer the disc centre—and seen through the openings in the two eccentrics—being necessary for setting-up the eccentrics for the gear to be used. The crank, which is slotted to enable its pin—representing the pin in the driving wheel—to be located according to the stroke of the cylinder, is mounted on a square in such a manner that its centre-line always coincides with the zero position of the crank angle graduation, and has its edges marked in inches, measured from the theoretical axle centre, to make the setting-up process as easy and rapid as possible.

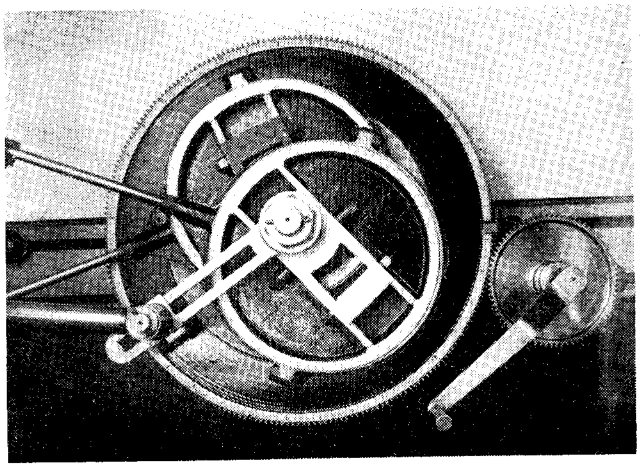
The Pen and Holder

A detail which gave much trouble at first was the pen and holder for describing the valve ellipse, and although spring-mounted as shown in Fig. 5, the strength of the spring was very difficult to determine. If too strong, the pen point broke, while too weak a spring failed to hold the pen up to the paper. As the result of experience, however,



Left: Fig. 3. Elevation of cylinder plate

Below: Fig. 4. Crank with eccentrics and graduated drum



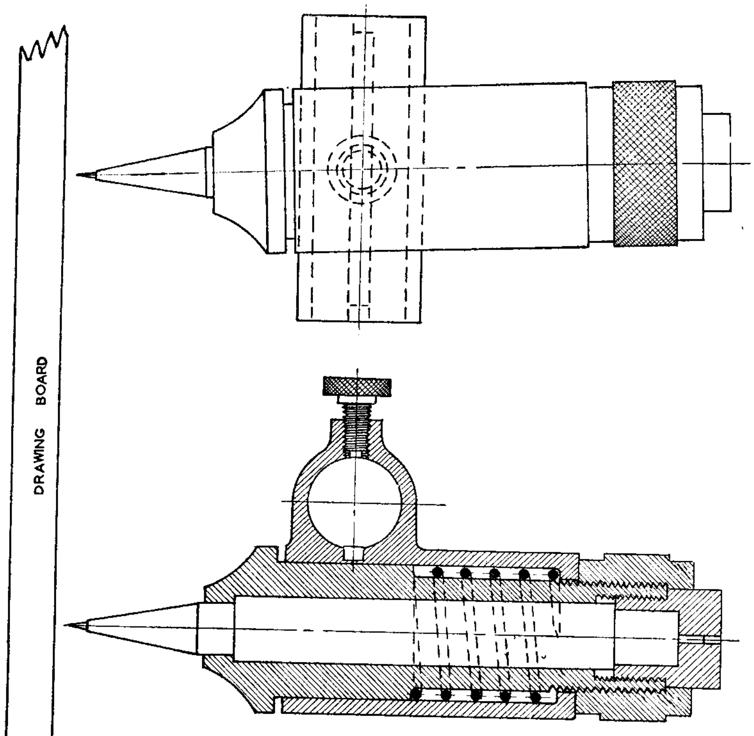


Fig 5. Pen and holder for drawing ellipses

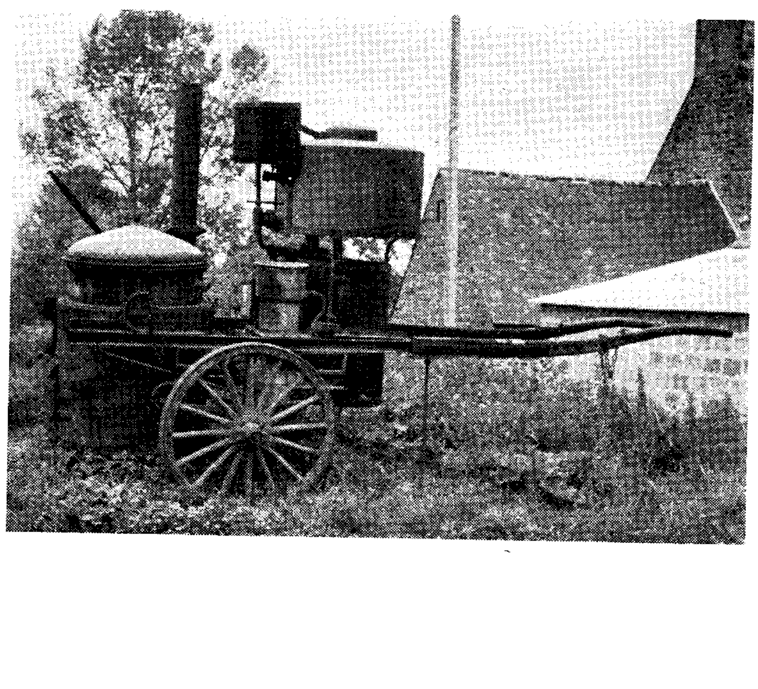
a suitable spring was designed, and it was deemed advisable to slow down the motion of the board during this operation, to ensure a reasonably long life for the pen. Incidentally, the resulting ellipse, though infallibly accurate when so produced, was quite different from all the writer has seen in text books and drawing office creations. Whereas the latter show figures having perfect curves on each side, the machine-drawn ellipse for any of the gears named earlier in this article has a flat on each side. This is logical, and is due to the suspension of movement of the valve, prior to reversal of motion, at a period when the piston is moving rapidly.

The model illustrated is operated entirely by hand, but a later model designed by the author is controlled by a small electric motor and foot-brake, the application of the brake cutting out the motor and holding the gear in the desired location until readings have been taken. A certain amount of complication is thus introduced, but it is anticipated that the extra cost will be justified in several directions, especially so when a designer may be working alone on a contract.

Editorial Note: To most amateurs and not a few professionals, there is, and always has been, an element of mystery about valve events in steam engines. This is due, presumably, to the fact that the valves are enclosed and cannot be seen when working. An apparatus like that described above can serve a two-fold purpose; it is interesting and unusual to design and construct, and it clearly reveals the movements of the valves and the effects of modifications in the dimensions of the components of the valve-gear.

A PROBLEM PICTURE

THE original photograph reproduced on the right has been sent us by Mr. J. H. Ahern, who took it while he was away on holiday. We think we know what the unusual vehicle really is; but we believe that some of our readers might like to try a few guesses, not only at what it is, but where it can be seen. N.B.—Mr. Michael Oxley has had nothing to do with it!



THAT OBSTINATE STARTER

BY B. TERRY ASPIN

FABRICATING A "MULTI"

A 4-CYLINDER MODEL PETROL ENGINE BUILT WITHOUT CASTINGS

By R. Berry

I THINK I had the first idea for building this model when I purchased a copy of that mine of information called *Model Petrol Engines*, by E. T. Westbury.

At the time, I was in H.M. Forces on a vehicle mechanic's course, and the information received here further inspired the thought. After demob., a start was made on a general assembly drawing Fig. 1, with the main idea of fabrication throughout. No castings at all were used in the construction.

After the g.a. drawing was complete, detail drawings were prepared from it, to give me an idea of the materials required.

The block is built up mainly of $\frac{1}{8}$-in. thick mild-steel plate, as shown in Fig. 2, with two thicker pieces Nos. 1 and 2, of $\frac{1}{4}$ in. and $\frac{1}{2}$ in. thick mild-steel fitted top and half-way down the block to form a seating for the insertion of the cylinder liners. This method gives a good volume of space around the liners for the cooling water.

The end plates Nos. 3 and 4 were marked off, drilled and bored for main and camshaft bearings together, being similar in all respects, except that the front plate has a slight bulge on the side to follow the contour of the timing cover.

In the top plate, No. 1, four holes were bored 0.005 in. undersize to receive the liners, and reamed out with plate No. 2 in position after assembly with a pilot reamer. The eight holes were next bored to accommodate the valve guides. Below these a piece of $\frac{3}{8}$ in. $\times$ $\frac{1}{4}$ in. mild-steel bar No. 5 was screwed and brazed in position, as shown, to form a ledge in which to fit the tappet guides.

This was drilled and reamed by spotting through the valve-guide seatings after final assembly, to ensure alignment.

The liners, made from close-grained cast-iron, were machined from the bar, and lapped in the bores, with a lead lap. When the liners were pressed in the block, it was found that the top and bottom of the bores had contracted slightly, owing to the press fit. These had to be lapped true again, this time using the lap by hand; quite a tedious job, but one which, with care, gives good results.

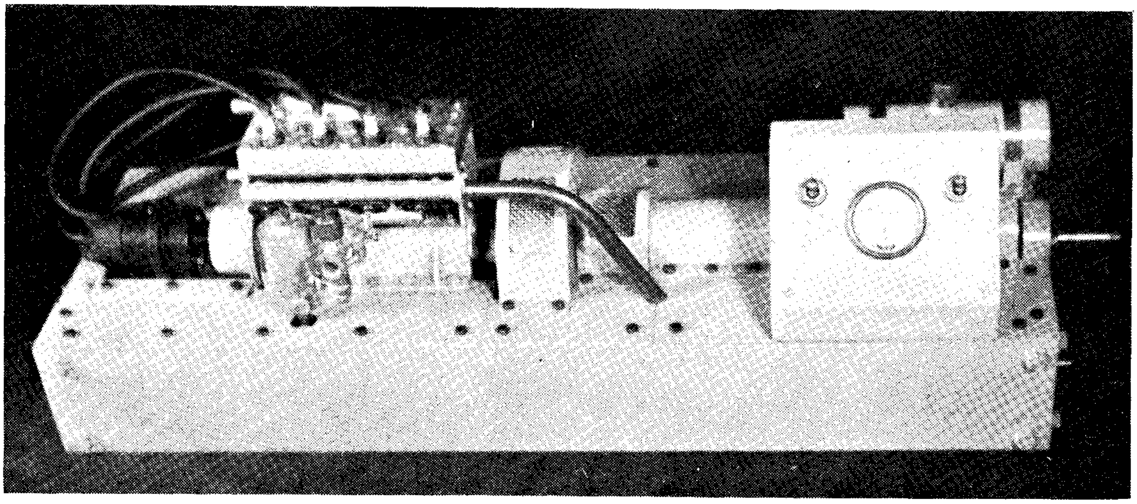
It will be seen that directly below the front main bearing a cutaway is formed in the front plate, Fig. 4; this is to allow for the insertion of the crankshaft. The shaft is threaded through the back plate, and the bearing slipped on the journal. The front end is passed through this cutaway, into the position in the front-plate, and the bearing fitted on. A tight-fitting false piece is pressed into place, and held there by one screw on the main bearing housing. Other fittings on the block, such as oil filler, and outriggers for mounting on the bed, were screwed and brazed to their respective plates before final assembly.

All around the inside of the base of the block, a frame of $\frac{1}{4}$ in. square brass was brazed to form a face on which to bolt the sump, which was made from 24-s.w.g. brass sheet, and is fitted with an oil trough to supply the big-ends with oil.

Next to be finished were the main bearing housings, complete with plain phos. bronze bushes bored to $\frac{1}{2}$ in. diameter.

Work was then concentrated on the crankshaft. This I fabricated from silver-steel journals, pressed into mild-steel webs. These joints were cross-drilled and taper pinned. All joints afterwards were silver-soldered. After milling the keyway for the timing pinion, the crankshaft was checked in the lathe centres and found to be 0.0015 in. out of alignment; not bad, I thought, for a built-up job, considering that the overall length of the crankshaft is $9\frac{1}{4}$ in.

The connecting-rods were tackled next. They are turned from solid dural bar, and bored on a small



The complete engine on its stand

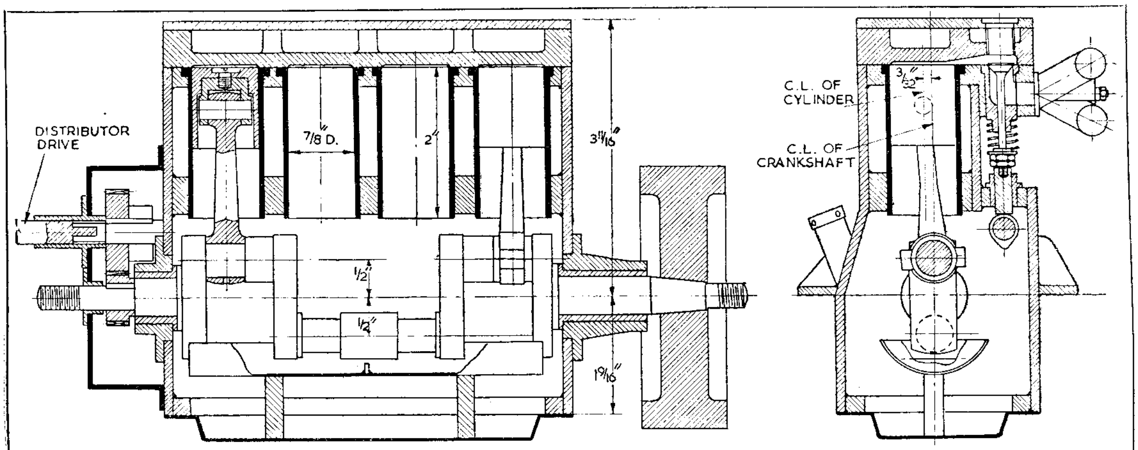


Fig. 1. General assembly, partly in section, of the "Multi"

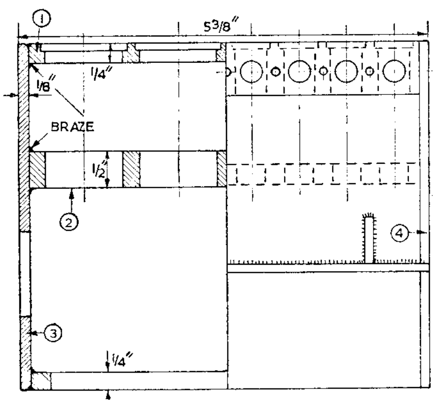


Fig. 2. Showing block construction

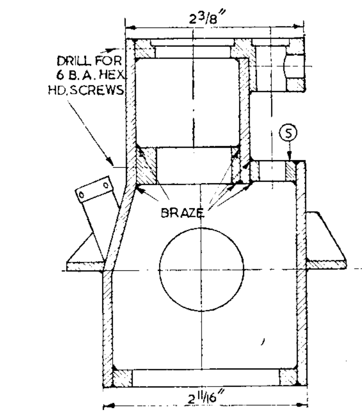


Fig. 3. Cross section of block

fixture I made for the faceplate. Plain pistons are made from cast-iron and lapped to a light push fit. The connecting-rods are attached to the pistons by fitting a small bracket as shown in Fig. 1, reamed $\frac{1}{4}$ in. diameter for the gudgeon-pins, and held captive to the crown of the piston by a flat-head screw.

This method gives a fully floating pin in the small-end, and prevents it coming into contact with the liners, and also saves a precision job of cross-drilling the piston skirt.

The camshaft was turned from $\frac{5}{8}$ in. diameter silver-steel, and I may say ideas for shaping the cam profiles were few and far between at the time, till one week an article appeared in THE MODEL ENGINEER concerning this operation, and was duly carried out as explained.

A good finish was obtained on the cam faces by the use of a lightly loaded oilstone pressing on the profiles as the shaft was turning slowly in the lathe.

The distributor is driven directly from the front end of the camshaft, and is coupled to the shaft by a tongue-and-groove method, Fig. 5, as used on the majority of automobiles on the road today. This driving tongue-and-groove is slightly off centre, to allow the rotor arm to be removed and replaced in the same position without upsetting the timing of the engine.

The distributor body is machined from 2 in. diameter Tufnol bar, and is fitted internally with the contact-breaker, rotor arm, segments and spring-loaded carbon brush, as in the larger Lucas type.

The timing gears are machined from phos. bronze, and were cut in the lathe by racking the saddle sideways, using progressively shaped tools, till the correct tooth form was achieved. The timing pinion on the crankshaft is $\frac{5}{8}$ in. P.C.D., with 20 teeth; an idler gear of the same dimensions carries the drive to the camshaft gear, which is $1\frac{1}{4}$ in. P.C.D. with 40 teeth. A cover of 16-s.w.g. steel is mounted over the gears; it has a friction holding device to hold the distributor, which allows ample movement for advancing and retarding the ignition timing, and provides a bearing for the distributor body.

The valve guides and tappet guides are made from phos. bronze. This material gives a nice finish and is suitable for high-speed reciprocating parts.

Valves are of silver-steel, with stems $\frac{1}{8}$ in. diameter, screwed at the end for the tappet adjustment-nuts, of which there are two locked on the stems. These nuts were case hardened.

The exhaust and induction manifolds were fabricated from $\frac{5}{16}$ in.

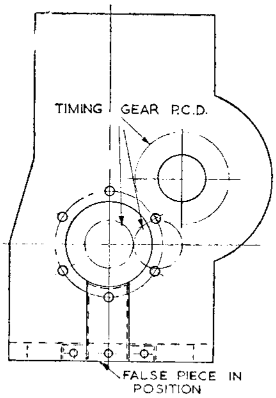


Fig. 4. Front plate

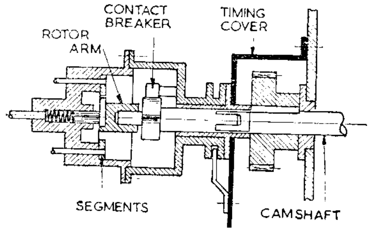


Fig. 5. Distributor assembly and drive pick-up from cam shaft

i.d. × 18-s.w.g. steel tube, and here I am afraid I deviated from working at home, as it was necessary to gas-weld all the branches on to the main tubes. This was accomplished at my place of work during one lunch hour, and a tricky job it was, too, even with the aid of a welding fixture. When cleaned up, however, and with a primary coat of aluminium paint, it looks remarkably lifelike.

The cylinder-head is made from dural bar. Combustion spaces were turned and milled on the lathe, and finally chipped and filed to blend the depressions into the correct shape. I was very pleased with this, and the result looks for all the world like the small Austin 7 head. Six holes were drilled in between the combustion spaces, coinciding with those in the block, to allow for the passage of water. The top of the head was milled out to give plenty of space around the plugs and over the pistons for cooling water. A top-plate was screwed on and sealed with a watertight compound.

The carburettor is of the tapered needle type, and I fitted an extra smaller jet by the butterfly valve to assist starting and slow running.

At the moment, I use a 6-V accumulator in conjunction with a full-sized ignition coil, and I can say I've had no ignition troubles at all. I don't mind this fairly heavy gear, as the engine was primarily designed for a stationary model. Much to my dismay, however, this high voltage coil caused a fair amount of local TV interference, so it was necessary to fit a suppressor in the h.t. lead. In fact, it was almost compulsory.

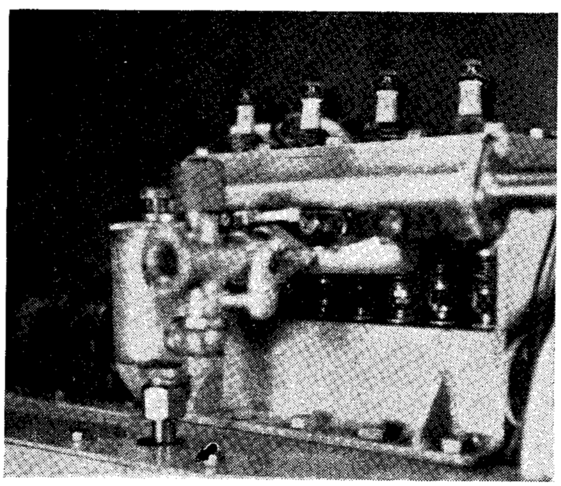
When the engine was having a good bench test after a few hours' running on a light load, one of the crankshaft joints fractured, fortunately with no damage to the other bits and pieces inside. This was rather a setback, to say the least, so rather than attempt to repair the thing I decided to make one out of the solid.

A piece of N.S.H. tool-steel was acquired from a tool store, with considerable inroads to the pocket, and this was shaped parallel and square all over, and three centres marked off each end with a vernier height gauge.

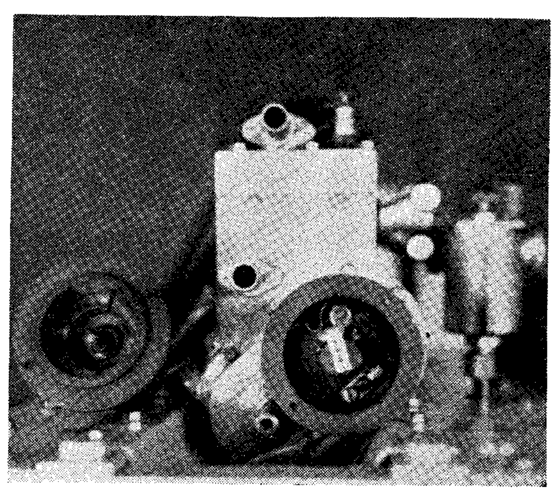
Beginning in the centre of the steel and working outwards, the job gradually took shape, and when finished I was surprised to find it took less time to make than did the first effort. Mind you, I'm not running down built-up crankshafts, they are first-class for a single or twin engine. But with a multi-cylinder job, the crankshaft has a tendency to wind up, especially when, as in this engine, there are only two main bearings.

The engine is mounted on a $\frac{3}{4}$ in. × $\frac{3}{4}$ in. × $\frac{1}{8}$ in. angle iron frame, 2 ft. 2 in. long × 9 in. wide and $3\frac{1}{2}$ in. deep, which is covered with 18-s.w.g. mild-steel plates. Sheet brass guards are fitted over the flywheel, and a flexible coupling which takes the drive to a shaft extending right to the end of the stand.

A round fuel tank is mounted on the stand at the extreme right, behind a small instrument panel which shows ignition switch and ammeter; this also contains the wiring and connections for the ignition system. The engine is finished with a dove grey enamel; brass and dural parts are brightened. The whole model was made over a period of three years, and many happy hours were spent in its construction, though it also caused a few headaches!



Showing the induction side of engine



The distributor with cap removed

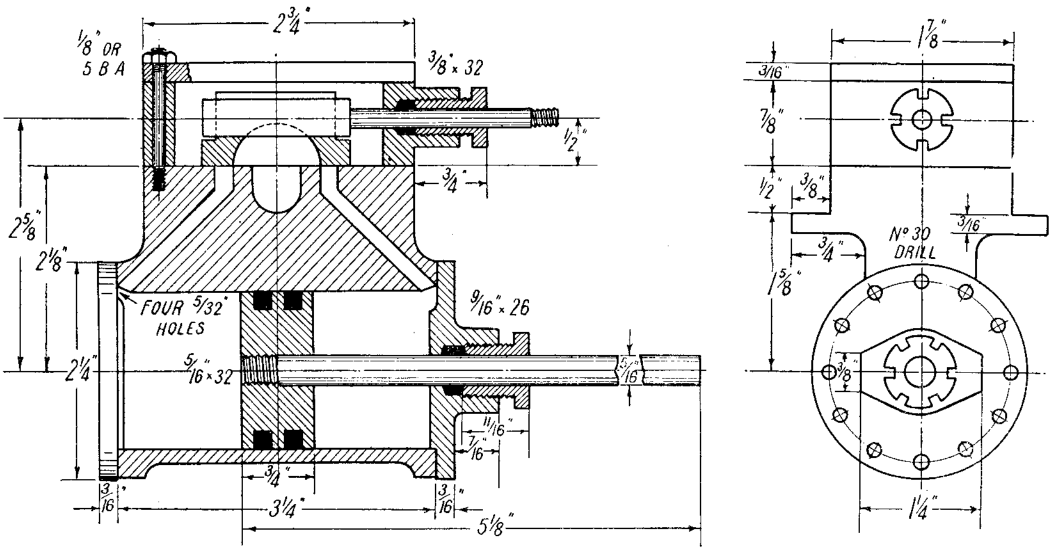
L.B.S.C.'s "Netta"

CYLINDERS FOR THE 5-INCH GAUGE ENGINE

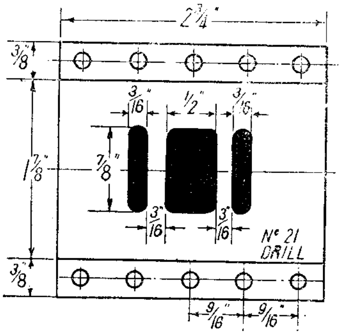
THE cylinders for the biggest girl of the quin family are just like those of the next size smaller, the 3½-**in.** gauge edition having the flat guide-bar seats on the piston-gland bosses, the buckle-driven slide valves, and the exhaust connection inside the frames. Provided that the available lathe is big and sturdy enough to carry the cylinder casting, mounted on an angleplate, on the lathe faceplate, the whole of the machining can be carried out in the manner described for the smaller cylinders. There are two or three small variations for which you can look out, as the job proceeds. The connection between the exhaust port and the upper surface of the casting, to which the exhaust-pipe flange will be attached, is an oval hole made by drilling two ¼-in. holes as close together as possible, and cutting out the wall between them. This can be done, either by chipping with a little chisel made from a bit of silver-steel, or by end-milling, in the same way as milling the steam and exhaust ports. The casting could be held in a machine-vice on the lathe saddle, portface uppermost and horizontal, and the side with the hole in it, facing the headstock. The hole should be set level with the lathe centres. If a ¼ in. end-mill, or preferably a home-made slot drill (which cuts quicker; mine do, anyway !) is put in the three-jaw and the casting fed on to it by turning the leadscrew,

It is quite possible that one or two of our enterprising advertisers will supply castings for the big quin, with the ports, steam passages, and exhaust way, ready cast in. If they do, it will save time and maybe trouble. The casting could also be lightened considerably, if some of the metal between the cylinder bore and the portface could be eliminated; I don't reckon to be a moulding expert—everyone to his trade—so maybe our foundry friends will give a thought to this matter, which would also reduce the cost a bit. The cylinders would, of course, warm up ever so much quicker if there isn't such a great bulk of metal to heat. The space between the actual cylinder, and the cleading plate, could be packed with felt, or asbestos, and so reduce radiation loss with considerable increase of efficiency.

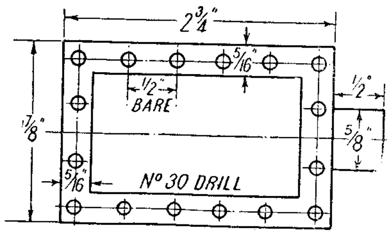
Reverting to the subject of end-milling for a moment, I've often wondered why those of our advertisers who make and market machine-tools, haven't put on the market, a small compound slide with the top of it formed like a flat boring table, with slots in it, similar to the face of a vertical-slide. Lugs could be provided for bolting it to the table of the usual type of small drilling-machine found in home workshops, and the result would be a nobby improvised vertical milling-machine, just the cat's whiskers for milling axleboxes, cutting ports, and various other jobs, normally done in the lathe, by aid of a vertical slide, when a regular miller isn't available. I find it much easier to set up a job on a flat table, than on a vertical-slide. To go a step farther, why not produce a glorified edition of the small drilling machine, with a screw feed, and the compound table integral ?



Section and end view of the cylinder for the 5-in. gauge engine



Portface



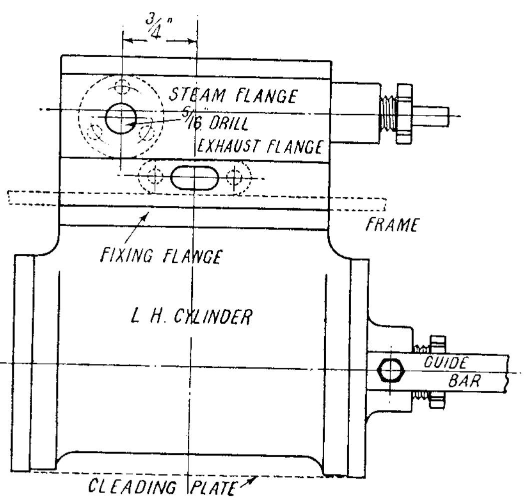
Steamchest

Alternative Way of Boring Cylinders

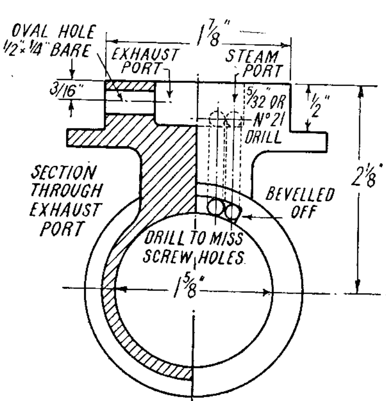
Unless the available lathe has a 9 in. faceplate, and a gap wide enough to clear an angle-plate of the size needed to carry the casting, it would be advisable to bore out the cylinders by aid of a boring-bar, with the casting bolted to the lathe saddle. Beginners are scared of this job, according to my correspondence, but there is nothing at all formidable or difficult about it. There never is, about anything, *when you know how*. If the portface of the casting is rough, just smooth it a bit with a file. If the corehole through the casting is reasonably central with the flanges, and parallel to the port face—just approximately, not to " mike " measurements—put a wooden plug in each end, mark the centre on it, and make a centrepop. Put it between the lathe centres, with the points in the pop-marks, and tighten the tailstock barrel, just enough to hold it in position, with the portface down, while you put some packing between the saddle and the portface. Then put a bar across the back of the casting, with a hole at each end, through which go the holding-down bolts; heads in the slots in the saddle, and nuts on top of the bar. Tighten the nuts, draw the tailstock away, run the saddle back from the headstock, pull out the bits of wood, and hey-presto ! there is your casting all set for boring. Just as easy as anything you ever did. That method of setting-up will naturally bring tears to the eyes of those good folk who could fill up three pages of this journal with explicit instructions on how to centre a bit of round bar; but I'll bet that it will appeal to our beginner friends !

If you haven't a boring bar, don't worry, just make one. That is very easy, too; all you need is a bit of stout round mild steel, a wee bit shorter than the maximum distance between lathe centres. Boring bars should always be as stiff as possible; in the present case, about 1 in. diameter would do fine. Centre each end, and drill a deep centre-hole with a centre-drill. If the bit of bar is chucked in the three-jaw, the overhang won't matter a bean, and the centre-drill can be held in the tailstock, the hole being drilled in the usual way. I once held the end of a 20-in. wooden roller, a replacement for our domestic wringer, in a 5 in. three-jaw on the old $4\frac{1}{2}$-in. Milnes pedal lathe which I kept as a standby when power cuts were the order of the day. An L-shaped improvised wooden steady was rigged up halfway along the roller, three empty cotton spools being interposed between the roller and the hole in the steady, to avoid friction; some roller-bearing, that—a *very* long way after Timken ! The end was centred with a big centre-drill in the tailstock chuck, and a $\frac{3}{4}$-in. hole drilled clean through the roller, doing the job from both ends and meeting in the middle, like the way they bored the St. Gothard tunnel. But the pedalling—migosh ! My feet are a few sizes smaller, and my leg muscles not quite so powerful, as those of a cup-winning football team; so when the other roller gave up the ghost, and replacement was needed, I got my good friend Denis Robins of Eythorne, to put the hole through on his big power lathe. Incidentally, friend Denis is making a fine job of an old-time 2-2-2, of which more anon.

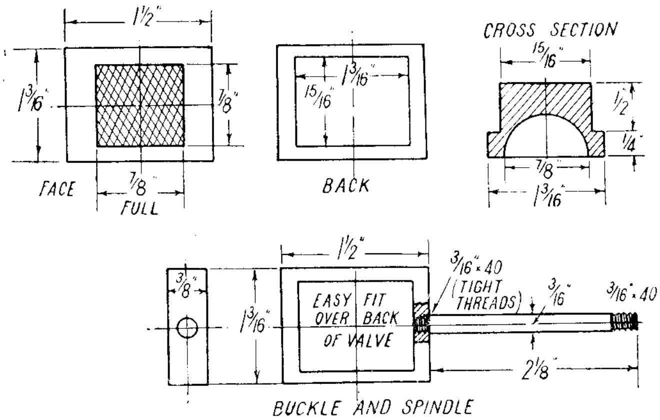
Getting back to the job in hand, drill a $\frac{1}{4}$-in. hole across the middle of the bar, and fit a $\frac{1}{4}$ in. or 0-B.A. setscrew at right-angles to it. File up a cutter, just like an ordinary roundnose turning tool, about $1\frac{1}{4}$ in. long, for the job in hand, and harden and temper to dark yellow, by the method I have described for pin drills, reamers, and so on. Put this through the cross-hole. Ordinary $\frac{1}{4}$ in. round silver-steel will do for the cutter, but if you can get a bit of high-speed stuff, it would be an advantage. File a flat on one end



Plan of cylinder



Cross section through ports



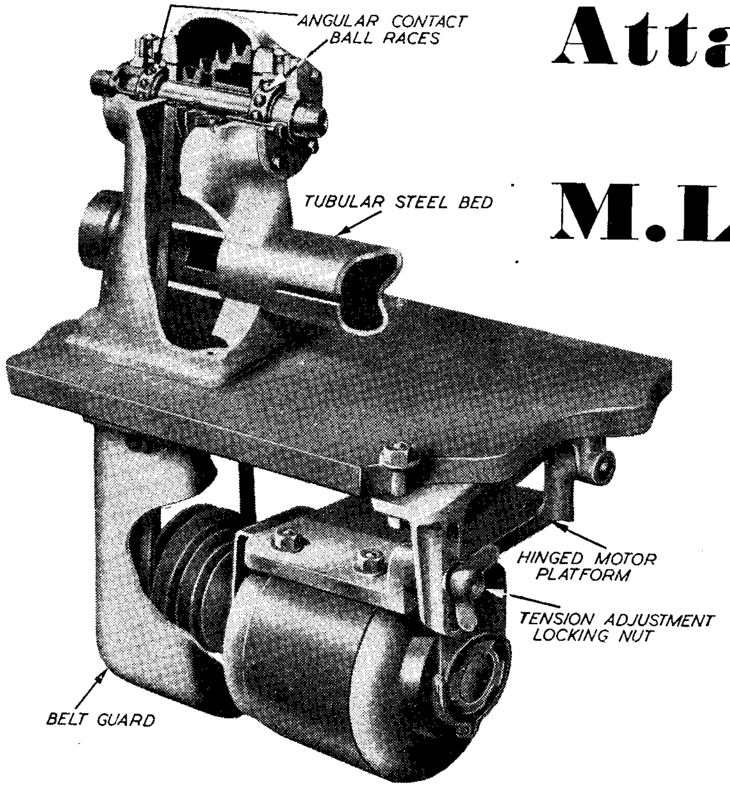
Slide valve and buckle details

of the bar, for the screw of a lathe carrier. Put the bar through the corehole of the cylinder casting, on the saddle; bring up the tailstock, and adjust it so that the bar is held between the centre-points, tightly enough not to shake, but easy enough to run freely; don't forget a drop of oil. Tighten the lathe carrier, adjust the cutter so that it is far enough out of the boring bar to take about $\frac{1}{16}$ in. cut from the core-hole, start the lathe, and traverse the casting along the bar, using the self-act if the lathe has screwcutting gear. A fine feed is advisable on a small lathe. For the next cut, pull the cutter a little further out of the boring bar, and repeat operations, continuing until the required diameter of bore is reached. Then take a traverse or two without shifting the cutter, and Bob's your uncle once more. I hope that our experienced readers will pardon my dilating on the above job, but the readers who aren't experienced, keep reminding me to remember them, so I do my best. We all had to make a start sometime !

The rest of the job is plain sailing, and can be done as described in the previous notes. Both cylinder flanges can be turned with the casting mounted on a stub mandrel in the three-jaw; but with this size of cylinder, in a small lathe, bring up the tailstock to support the end of the stub mandrel, otherwise there may be chattering. The mandrel shouldn't project beyond the end of the cylinder; the tailstock centre can go in to meet it. This will allow the whole width of the flange to be faced at one go; a roundnose tool bent to the left, is best for the job. The portface can be machined off, and the ports cut (a $\frac{3}{16}$ in. slot drill should be used), also the passages drilled, in the same way as those for the 3½-in. engine; note, there are four holes to each port instead of two, and they should be drilled in two groups of two each, to leave a space between for the cover screw.

Instead of one packing groove in the piston, cut two, $\frac{3}{16}$ in. wide, and $\frac{3}{16}$ in. deep, to accommodate a couple of rings made from $\frac{3}{16}$ in. square braided graphited yarn, with the ends cut off at an angle, to form a scarf joint. This will give better results than one large ring. The piston could be made from dural, if a piece is available. The dural piston in the low-pressure cylinder of my Webb compound *Jeanie Deans* has never given a farthingsworth of trouble, since the day it was put in. Dural could also be used for the covers, as they would then look like bright iron, and please Inspector Meticulous. Mention of iron reminds me that cast-iron could be used for these cylinders, if there is any likelihood of the engine being used for constant hard work, such as hauling loads of kiddies at fetes and similar gatherings. In that case, I should recommend rustless steel pistons with two rings on each. Cylinder drain cocks, as described for *Britannia* and other engines, should also be fitted, so that the cylinders could be blown out and left absolutely free of water, before putting the engine away after a spell of work. In addition, a $\frac{3}{16}$ in. × 40 hexagon-headed setscrew should be fitted in the middle of each front cylinder cover, so that a shot of cylinder oil, with colloidal graphite in it, could be squirted in as an extra precaution. Drain cocks could also be fitted to the ordinary bronze cylinders if desired, to get rid of condensate water when starting; but with slide-valve engines, they are not essential, as any trapped water will lift the valve from the portface, and escape via the exhaust pipe. However, many builders like to see a cloud of steam blowing out of the front of the engine when starting, so they will know what to do; incidentally, when the common or garden everyday artist draws a picture showing a steam locomotive in it, he invariably shows steam coming out of it, everywhere it shouldn't. I should imagine that the idea is to cover up his ignorance of the " works," for the steam invariably blankets the valve-gear and other moving parts. Yet it would be *so easy* to study any photograph of a locomotive, and draw or paint the proper parts !

The accompanying drawing shows the shape and dimensions of the slide-valve, buckle, and valve spindle; and as these are machined and fitted in exactly the same way as specified for the 3½-in. gauge engine, further description is unnecessary. The full-size locomotives had piston-valves; and several readers have written to me, requesting that I should give an alternative design for the 3½-in. gauge and 5-in. gauge cylinders, incorporating piston-valves. Had I only been describing these two sizes, I would have specified piston-valves instead of slides; but as I am " bringing up quins " in a manner of speaking, it made the job a little easier, to make the family really quins, all with the same characteristics. Piston-valve cylinders being a different shape and size, would involve alterations in the frames, for a start; and we would need also to alter the valve-gear to suit. If I can possibly squeeze in the time, I'll see if anything can be done to oblige; but will make no definite promise. If any builder of the 5-in. or 3½-in. gauge engines, cared to draw on his imagination as to what these engines would look like if entirely rebuilt to modern standards, and build his engine accordingly—an interesting job which would appeal to your humble servant —he could use the piston-valve cylinders and valves which I specified for a 5-in. gauge Great Western 1500 class 0-6-0 tank engine, with outside Walschaerts gear, or the cylinders and motion of *Doris* or *Pamela*, for the smaller engine. Well, so much for that; the next stage will be guide bars, crossheads, and connecting-rods, and I hope to be able to do all that lot together.



The "power head" of the M.L.8 lathe

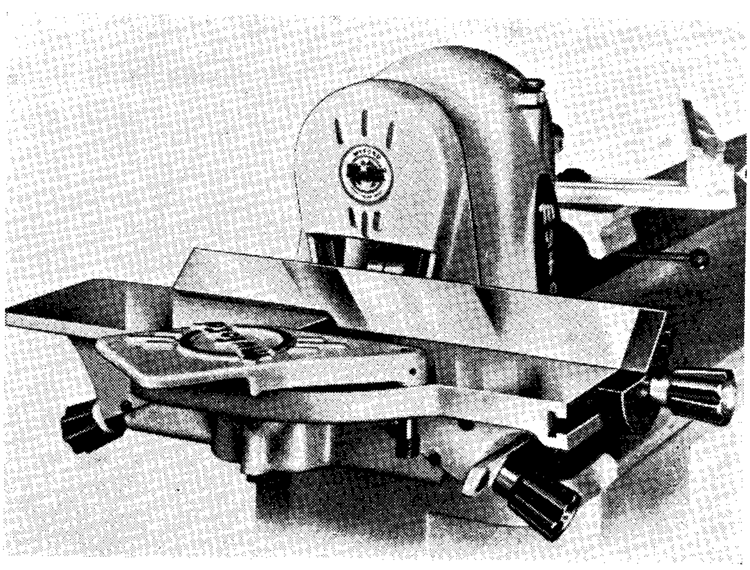
Attachments for the M.L.8 Lathe

THE Myford ML8 woodworking lathe is already well known to our readers, having been demonstrated on several occasions at "M.E." Exhibitions, besides being described in our editorial and advertisement pages. However, the object of the present review is to bring to the notice of readers the progress which has been made in the development of various attachments for this lathe since its original introduction, and which make it one of the most versatile multi-purpose machine tools which has ever been available to either the amateur or professional woodworker.

It may be said at the outset that nothing new is claimed for the idea of using a relatively simple lathe as the nucleus of a complete machine tool equipment; model engineers, in particular, are fully aware of the possibilities of extending the scope of the lathe by the fitting of various attachments. But in the majority of such developments, the accent has been on the metal-working lathe, and serious attempts to produce, on a commercial scale, additional equipment for woodworking lathes have been relatively few and far between.

In the M.L.8 lathe, the basic design has been arranged in such a way as to facilitate the use of attachments, being in many respects a breakaway from conventional design, and a reversion to first principles, by using the headstock, with its mandrel and multi-speed motor drive, as the central and essential feature, to which all other components, whether regarded as attachments or otherwise are related. A brief review of this unit will not be out of place here, in view of its importance in the general scheme of things.

The headstock comprises a hollow one-piece casting, with a broad base for mounting on the bench or machine stand, and bored horizontally to form housings for the mandrel bearings and the round tubular bed respectively. A large diameter mandrel is fitted, running in angular-contact ball races which take both radial and end thrust, and can be adjusted to take up end play by means of a screwed collar, which is provided with a locking screw. Dust-excluding endplates are fitted to both bearings. The mandrel is screwed at both ends, right- and left-handed respectively, with thrust shoulders


The planing and rebating attachment, belt-driven from the left-hand end of mandrel

and registers to mount chucks, faceplates, etc., and is fitted with a 4-speed pulley for ½-in. vee-belt, to give speeds of 712, 1,140, 1,780, and 2,850 from a ½ h.p. motor running at 1,425 r.p.m. This is mounted in an inverted position below the headstock, by a tilting bracket which provides for easy speed changing and belt tensioning. The drive is completely enclosed, but a removable cap on the top of the headstock provides ready access to the belt pulley, and a further refinement is an indexing plunger which, in conjunction with holes in the pulley rim, gives 24 equidistant positions to the spindle.

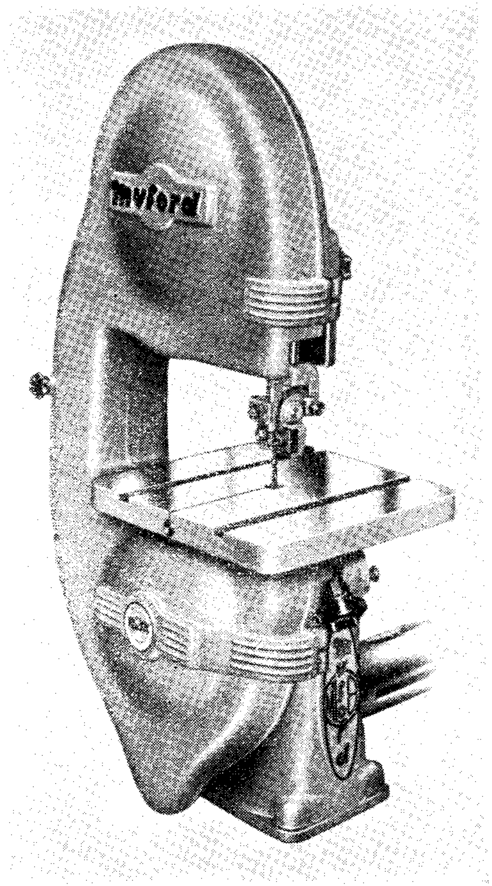
To this power head, beds of seamless steel tube varying in length, up to a maximum giving a length of 42 in. between centres, can be fitted, to take the usual wood turning fixtures, such as the tailstock and hand-rest support, or to serve as a mounting for other attachments; in all cases, quick-acting hand clamping devices are provided, so that they can be brought into position and secured without the use of tools. It will readily be understood that the practical value of any machine tool fixture depends to a great extent on being able to bring it into operation with the minimum delay, and this feature has been fully considered in the design of the attachments to be described.

Rear Turning Attachment

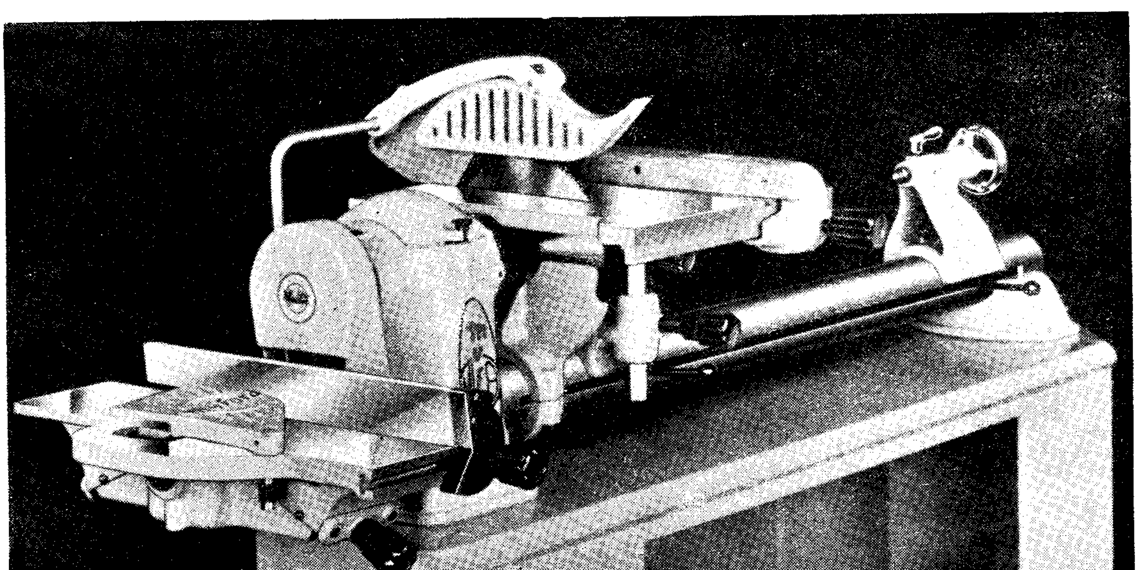
This considerably increases the capacity of the lathe for dealing with turning large diameters, for which the left-hand end of the mandrel is utilised. It comprises a special hand rest mounted on a slotted swivel arm which gives a wide range of position adjustment, and is locked by two quick-acting clamp levers. The design of the offset hand-rest base provides rigid support when dealing with internal work. Note that the faceplate, and any other fittings which may be used on the left-hand end of the mandrel, must have a left-hand internal thread.

Circular Saw Table

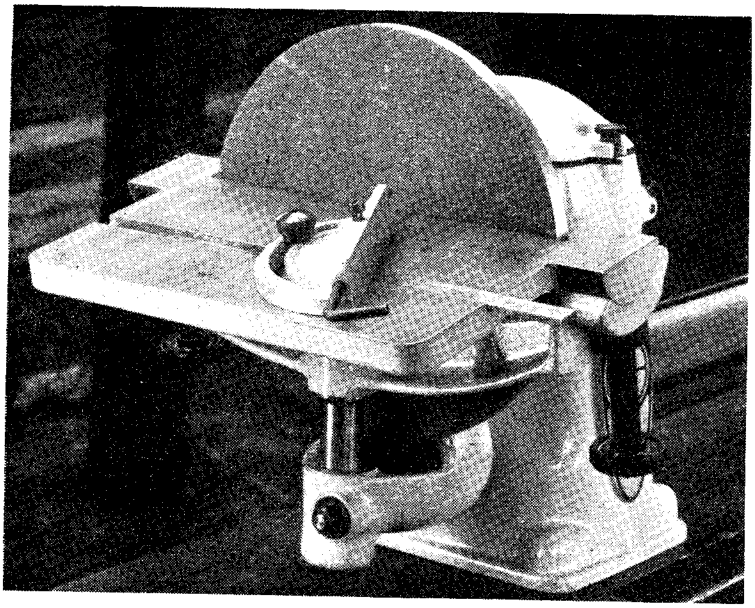
The table measures 14½ in. from front to back, by 12½ in. in width, and is provided with rising and falling adjustment, also tilt up to a maximum of 45 deg. A fence



Right: The bandsaw attachment, direct driven from left-hand end of mandrel



The M.L.8 with circular sawing and planing attachments fitted



Large sanding disc, with tilting table and adjustable mitre block

capable of working on either side of the saw is provided, also a groove to take an adjustable angle fence or mitre block, which is listed as a separate fitting: a guard and splitter can also be supplied. Saws up to a maximum diameter of 8 in., in a range of tooth forms for various purposes, can be used, the maximum depth of cut being 2$\frac{3}{4}$ in. for ripping and 1$\frac{5}{8}$ in. for cross cutting. The saw arbor screws directly on the mandrel, so that it is not necessary to use tailstock support, and a wobble saw arbor, for grooving and dovetailing up to a width of $\frac{5}{8}$ in., is available.

Bandsaw Attachment

This is mounted on the lathe bed extension at the left-hand side of the headstock, and may thus be fitted while leaving the main part of the bed free for wood turning or the mounting of other attachments. It uses 10 in. diameter wheels, the top one running in two ball bearings, with full alignment and blade tension adjustments, in a rigid cast housing, with complete enclosure, yet instant accessibility by a hinged side casing. The maximum cutting capacity is 3$\frac{3}{4}$ in. thickness, with a throat capacity of 9$\frac{1}{4}$ in.; the size of the table is 10 in. by 10 in., with a tilting range up to 45 deg. forward and 5 deg. backward. Grooves are provided for a mitre block. Blade guides with hardened rollers are provided above and below the table, and are interchangeable; normal blade width is $\frac{1}{4}$ in., but $\frac{3}{8}$ in. blades can be used, and blade length is 64 in.

Planing Attachment

Fitted in a similar position to the bandsaw, and thus capable of being available at the same time as other fittings, this uses a three-bladed rotor machined from solid steel, belt-driven from a pulley on the headstock mandrel to run at a maximum speed of 5,650 r.p.m. It will plane up to a maximum width of 4$\frac{1}{2}$ in., and rebate to a depth of $\frac{3}{8}$ in. The table levels before and behind the cutter head are independently adjustable by readily accessible control handles, and the fence is adjustable up to an angle of 45 deg. either way. A driving belt guard and a spring-return guard are fitted as standard.

Sanding Discs

These are available for fitting at either end of the mandrel, the right-hand one being limited, by the swing over the bed, to 8 in., but still large enough for quite useful work; the other is 10 in. diameter, and has a specially large table, 11 in. by 6 in., with tilting adjustment up to 45 deg. A similar tilting range is provided for the smaller table used with the 8 in. disc, and both tables are slotted to take a mitre block.

Grinding and Polishing

Arbors are available for mounting grinding wheels or polishing mops, the former up to 6 in. diameter, and the latter up to 8 in. diameter, on the left-hand end of the mandrel. The hand rest of the rear turning attachment is adaptable for use as a tool rest when grinding.

Long Boring Fixture

The demonstrations of deep drilling and boring in wood given at "M.E." Exhibitions are made possible by means of a simple fixture mounted on the hand-rest base, carrying a hollow centre through which a long auger, available in $\frac{5}{16}$ in. and $\frac{3}{8}$ in. diameter, can be inserted. This particular operation, so essential for many parts such as turned lamp standards and pedestals, is often difficult to carry out properly on wood-turning lathes in the absence of this ingenious fitting.

Other available items of equipment for the M.L.8 lathe include a timber support platform, useful when sawing large panels, a compound sliderest for metal turning, a spinning rest for obtaining increased leverage on metal forming tools, and a wide range of cutting tools, centres, chucks, faceplates and adaptors.

IN THE WORKSHOP

BY DUPLEX

A SCREWCUTTING AND INDEXING ATTACHMENT

APART from the introduction of the Norton gear-box, it is somewhat surprising how little has been done in the past hundred and fifty years to make setting up the lathe for screwcutting less irksome and time-wasting. With the usual provision of a set of change wheels, a quadrant, and a leadscrew, we, like Henry Maudslay in 1797, may be faced with having to rearrange the wheel trains several times in the course of machining a single piece of work, in order to obtain either a fine feed or one or more screw pitches. This entails removing one set of wheels, sorting out another set with the aid of a chart, and then setting up and meshing the new train by altering the positions of the wheel studs. The Norton gear-box enables changes of screwcutting pitches and rates of traverse to be made by merely altering the positions of the small levers on the front of the box.

This is clearly a great advantage in toolroom lathes, and in those used for a wide range of turning operations: but the amateur worker, who requires his lathe to be an all-purpose machine, may find a gear-box of this kind somewhat of an encumbrance when it comes to dividing from a change wheel attached to the tail of the mandrel, or fitting a dividing head to the lathe headstock. Again, there are times when, as in some milling operations, the saddle has to be traversed automatically while the lathe mandrel remains stationary. There are, of course, always those who would be dogmatic in a case like this by affirming that one type of machine tool is right and the other wrong; but the suitability of a machine depends essentially on what is required of it. After working, those of us who are tidily disposed are probably in the habit of refitting the lathe wheel train to give the fine feed normally used, only to find that the next job that comes along is one calling for screwcutting.

It was, therefore, not long after taking delivery of a new Drummond lathe that a decision was made to try and simplify the standard arrangement, and a description of the resulting modification was given in an article published in this journal on May 17th, 1951. As shown in Fig. 1, this design sought to keep separate the two wheel trains for the automatic traverse and the screwcutting feed, so that either could be used at will independently of the other. The fine feed illustrated has the advantage of a primary belt drive; this eliminates gear noise, and provides a safety slipping device in the event of a jam.

The first gear wheel in the traversing train is fitted with a lever-operated mechanism for sliding the wheel out of mesh with the second gear wheel; this provides a ready means of engaging and disengaging the automatic feed and, at the same time, it enables the gear train to run free when the screwcutting gear is in operation. The wheels completing the screwcutting train, by connecting the mandrel wheel to the leadscrew wheel, are carried on a

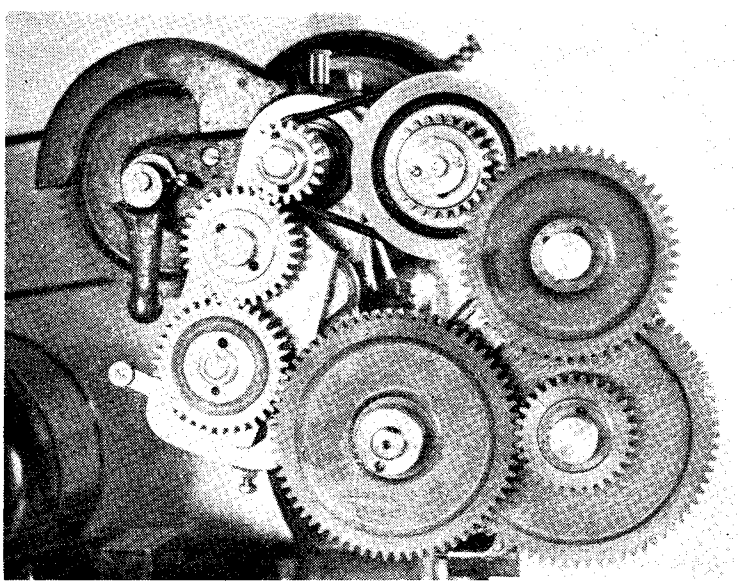


Fig. 1. The original screwcutting quadrant

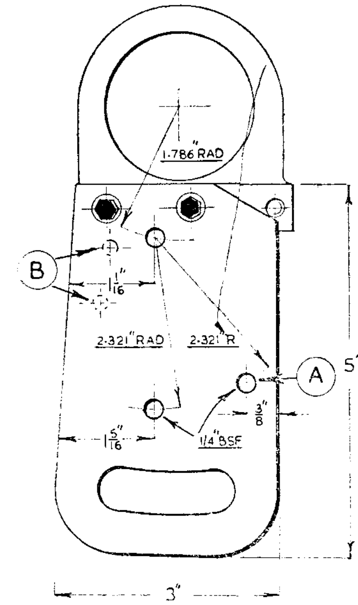


Fig. 2. The quadrant, showing the alternative stud position at A, and at B the screw holes for attaching the detent plate

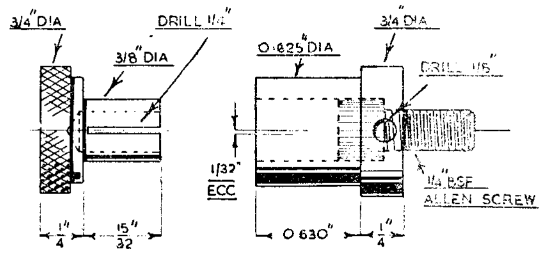


Fig. 3. The wheel stud and retaining plunger

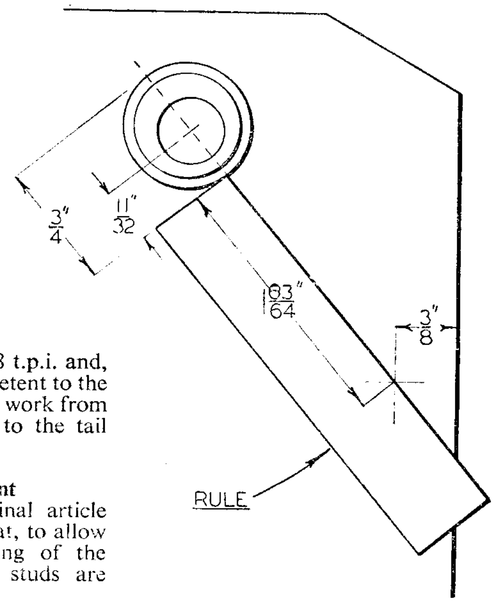


Fig. 4. Locating the stud hole—A

separate quadrant, which is pivoted on the adjusting collar of the mandrel bearing bush, and is locked to the existing stud fitted to the headstock casting. The construction of this quadrant, with its eccentrically mounted wheel studs, was fully described in the article previously mentioned, and the purpose of the present notes is to refer to modifications made to increase the screw-cutting range, and also to enable simple indexing to be undertaken.

When the secondary quadrant was originally designed, the object was to enable all even-numbered threads from 16 t.p.i. to 26 t.p.i. to be cut by changing the leadscrew wheel alone. For this purpose, the wheels needed ranged from 40T to 65T, rising by increments of five teeth. Recently, however, we had to make some parts in plastic material and screwcut them 8 t.p.i.; in addition, they had to be finished twelve-sided. To carry out this work, and to make provision for future needs, it was decided to alter the secondary quadrant so as to extend the screw-cutting range to include 8 t.p.i. and, at the same time, to fit a detent to the quadrant for indexing the work from a change wheel secured to the tail of the mandrel.

Alterations to the Quadrant

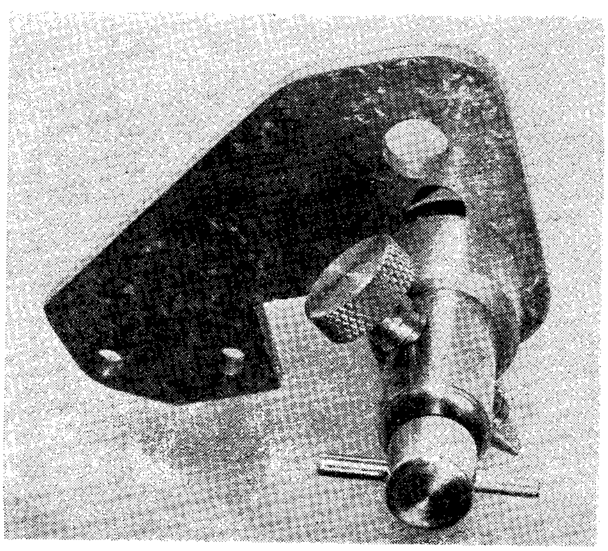
Reference to the original article will remind the reader that, to allow for adjusting the meshing of the gear wheels, the wheel studs are made 1/32 in. eccentric.

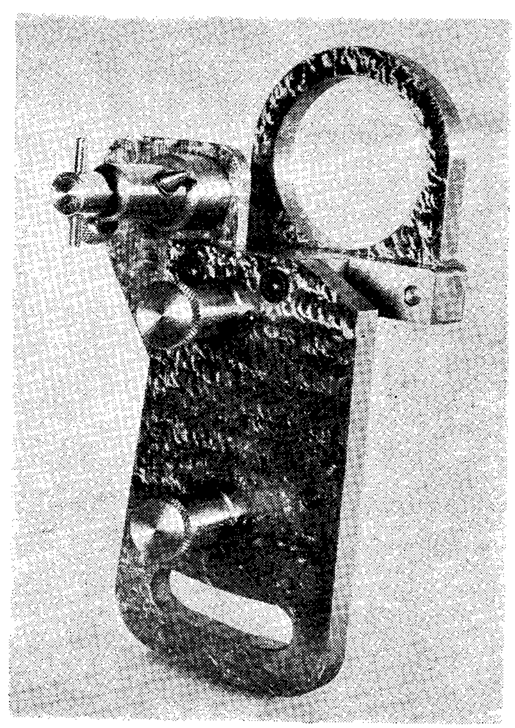
The location of the new stud hole, shown at *A* in Fig. 2, enables the intermediate wheel to mesh with leadscrew wheels as small as 20T. This modification takes the place of making a new quadrant with a greater range of movement. As the stud for the second intermediate wheel has to be readily detachable, it is made to the dimensions shown in Fig. 3 and is secured in the hole *A* by means of a 1/4 in. B.S.F. Allen cap-screw.

For marking-out the centre of the screw hole, paint the quadrant

Right—Fig. 6. The detent assembled on the quadrant

Below—Fig. 5. The finished detent





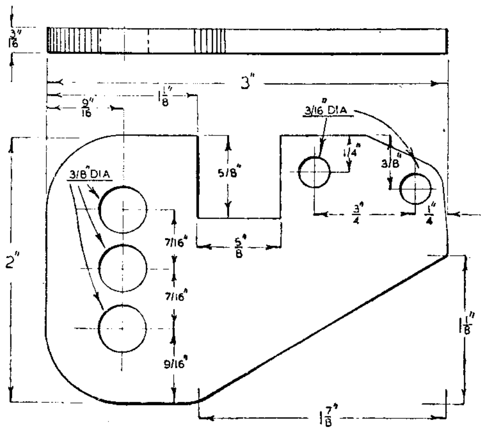


Fig. 7. The detent mounting plate

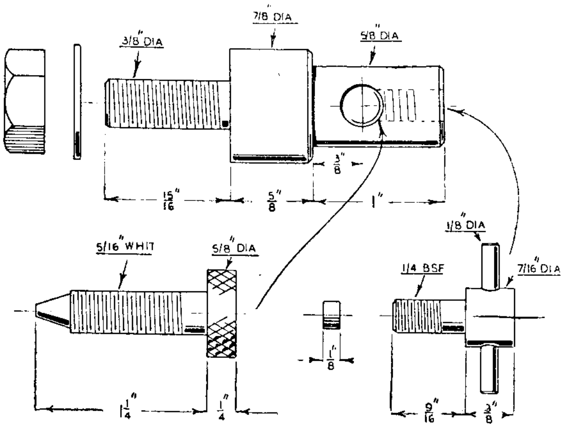


Fig. 8. The detent components

with marking fluid, and scribe a line with the jenny calipers, $\frac{3}{8}$ in. from the right-hand edge. The theoretical centre distance between the 30T. and 35T. intermediate wheels is 2.321 in., and the diameter of the base of the upper stud is 0.750 in. However, when this stud is turned into the position shown in Fig. 4, the distance from its centre to the edge of the base is reduced by 1/32 in. and becomes 11/32 in. Subract 11/32 in. from 2.321 in. and the difference of approximately 1 63/64 in. can be set off with a rule, represented in Fig. 4. The error, amounting to some 7 thou. in., is corrected by rotating the eccentric stud when adjusting the meshing of the wheels. Where studs with their bores concentric with the wheel mountings are fitted, the centre for the second wheel can be accurately located by means of a toolmaker's button. After the wheels have been set correctly in mesh, the button on which the second wheel is mounted is secured in place, and the work is then transferred to the lathe face-plate.

With the aid of the test indicator, the work is set to centre the button correctly, and the hole for mounting the stud is then machined.

As, from time to time, the position of the second wheel stud will be changed from one fixing hole to the other, it is advisable to make register marks on both the stud and the quadrant, to indicate the settings for the correct meshing of the wheels.

With the quadrant as now altered, the following screw pitches can be cut by changing the leadscrew wheel only, and altering the position of the wheel stud for threads of a pitch coarser than 16 to the inch.

Mandrel wheel 20T. throughout

Leadscrew wheel	Threads per in.
20	8
25	10
30	12
35	14
40	16
45	18
50	20
55	22
60	24
65	26

For cutting threads of other pitches, the quadrant can be detached by removing the single clamp-nut and the ordinary lathe quadrant is then fitted. To save wear and unnecessary gear wheel noise, the 30T idle wheel is removed from its stud when the screwcutting gear is not in use.

A Detent for Indexing

To add to the usefulness of the secondary quadrant, a detent was fitted to the quadrant plate for indexing the work from a change wheel secured to the tail of the mandrel.

This change wheel is located by means of a taper pin engaging in the mandrel collar and, in addition, the wheel is secured with a hexagon-headed screw fitted to the mandrel bore.

As shown in the drawing, the detent plate is cut to shape from $\frac{3}{16}$-in mild-steel stock, and three $\frac{3}{8}$ in. diameter holes are drilled for mounting the detent with as little overhang as possible in relation to the different sizes of change wheels fitted to the mandrel. The plate is secured to the back of the quadrant with two 2-B.A. Allen cap-screws. As the detent itself is also used at times on the standard quadrant, it is made with a loose distancing collar and the threaded shank is left fully long.

The tip of the detent-screw should be turned to fit the tooth spaces of the change wheels, and a Whitworth thread is used to give quicker operation. The clamping-screw is furnished with a brass pad-piece to save damaging the threads of the indexing screw.

The following commonly used divisions can be obtained by securing either of two change wheels to the lathe mandrel.

Mandrel wheel	Divisions
20T.	2, 4, 5, 10, 20
24T.	3, 6, 8, 12, 24

These divisions will serve for much of the ordinary work of making hexagon and square-head screws, as well as drilling cylinder covers and other parts; in addition, any wheel up to 40T. can be fitted to the mandrel for indexing the work.

The attachment described has certainly proved its worth in the workshop, and threads are now cut with alacrity as opposed to the slight feeling of resentment formerly felt when having to dismantle and re-assemble complicated wheel trains.

For the fine traversing feed normally used, a 65T. wheel is kept on the leadscrew; this enables the favourite 26 t.p.i. thread to be cut by merely pushing over the lever to disengage the power feed, and then swinging the small quadrant to bring the idle wheel into mesh with the leadscrew wheel.

MORE UTILITY STEAM ENGINES

Boiler Design and Construction

By Edgar T. Westbury

NO doubt there are many readers who are thinking that it is time I gave them something original and up-to-date in boiler design, in view of the amount of space I have taken up in discussing existing designs of both full-size and model boilers. I am, therefore, submitting a design which, in so far as its details are concerned, is entirely new, and which I believe to embody all the essential features for rapid and efficient steaming, though its basic design cannot be claimed as novel, and in fact, its roots go back even further than any of the other boilers which have been described in these articles. I have not actually built a boiler to this design, though a somewhat similar, but more primitive one was made by a friend to my instructions some years ago, and behaved fairly well in a fast cruising boat.

Many years ago, I knew a blacksmith in the West of England, who told me that his father—or it might possibly have been his grandfather—had made some of the mechanical parts for one of the very first steam carriages to run on the roads, the inventor of which, he believed, was a Mr. Gurney. I was unable to get more information about this at the time, though later investigation led me to believe that the person concerned could have been none other than Goldsworthy Gurney " a medical gentleman and scientific chymist " of Cornwall (how prolific this little corner of England has been in engineering genius !) who was certainly a pioneer of road locomotion, and had ideas far in advance of his time.

In 1825 he devoted his attention to the design of a steam engine specially suited to propelling a road vehicle, and at the very outset he realised the necessity of developing a lighter and more efficient steam plant than those that had previously been applied to the purpose, the boilers of which were merely adaptations of the crude " pot " or internal-flue boilers used in stationary practice. In the attempt to reduce weight, he introduced a revolutionary form of boiler, which gave far more steam output for its size and weight than the above types.

If readers will pardon a slight digression, it may be noted that many of the pioneers of steam locomotion, both road and rail, were hampered by the fallacy that the adhesion of the wheels would not be sufficient to transmit the required propulsive effort, so much so that much labour and skill were wasted in designing mechanical equivalents of horses' feet, or similar " walking " devices. This idea was originally shared by Mr. Gurney, though it was quickly dispelled when practical experiments were made. However, it may well be that in making allowances for the weight and complication of such mechanism in the design of the vehicle, he was obliged to concentrate on keeping down the size and weight of the boiler. Thus, in devious ways, restrictions and handicaps serve their purpose in promoting progress.

The salient feature of Gurney's boiler was that there was no part of it, not even excluding the bars of the grate, in which metal exposed to the fire was out of contact with the water in circulation. In this respect, it was unique among boilers of its time, and though similar features, including water-cooled fire-bars, have often been seen since, few of the early designers had such a clear conception of the essential requirements for a light rapid-steaming boiler.

The Science Museum publication, " Steam Road Vehicles," contains a description of Gurney's boiler, including a drawing, but the one I reproduce here is taken from a much older publication on the steam engine, dated 1856, which gives a more complete idea of the constructional design, if allowance is made for the rather crude draughtsmanship common to many text-books of the period.

Despite the ingenuity of Gurney's boiler, it was by no means immune from trouble, which is not at all surprising in view of the poor materials and crude methods then in use. Seamless tubes had not been invented, and the tubes had to be made by rolling strips of wrought iron and butt-welding the seams, so that failures and leakages were frequent. It is not clear how the tubes were joined to the elbow pieces, or into the large drums, but these joints were obviously potential sources of trouble as well.

Nevertheless, Gurney's coaches ran a regular service in 1831 between Gloucester and Cheltenham, keeping up an average speed of 10 to 12 miles per hour, including stoppages. The failure of this service was due not to inefficiency, but to the activities of opposing parties, mostly owners of horse carriages, who did not scruple to use any means, fair or foul, to obstruct these newfangled vehicles.

The Adapted Design

In adapting the ideas of Goldsworthy Gurney to a small boiler suitable for marine plant, or any other purpose where rapid steaming and light weight are required, I have made no attempt to copy the exact shape or the constructional details, but merely to retain the basic principles and salient features. It will be noted that the major components consist of three large diameter tubes, disposed horizontally across the front or fire-door end of the furnace. Two of these are water drums, and besides being connected together by vertical tubes near the ends, which act as downcomers, receive the upper and lower ends of small diameter " hairpin " tubes which constitute the main generating elements.

The third and largest of the cross tubes serves as a steam drum, and is connected to the upper water drums by two short tubes at an angle of 45 deg.; the main object of this drum is to act as a steam separator, and it is set well back from the water drums to avoid increasing the height abnormally. Its length may well be less than that of the other two drums, as shown, but this feature is optional.

I have not given dimensions of this boiler, as these are optional, and there is also some latitude of shape and proportions of the com-

Continued from page 642, *June* 10, 1954.

ponents, but I suggest that a boiler having water drums $\frac{7}{8}$ in. diameter by 6 in. long, and eight generating tubes $\frac{1}{4}$ in. diameter by 8 in. long (before bending) would suit a fairly fast cruising boat of 3 ft. 6 in. to 4 ft. long. The width of the boiler together with the number of generating tubes, could be adapted to suit the available beam, and the boiler is suitable for firing by means of either a torch blowlamp or an atomising burner.

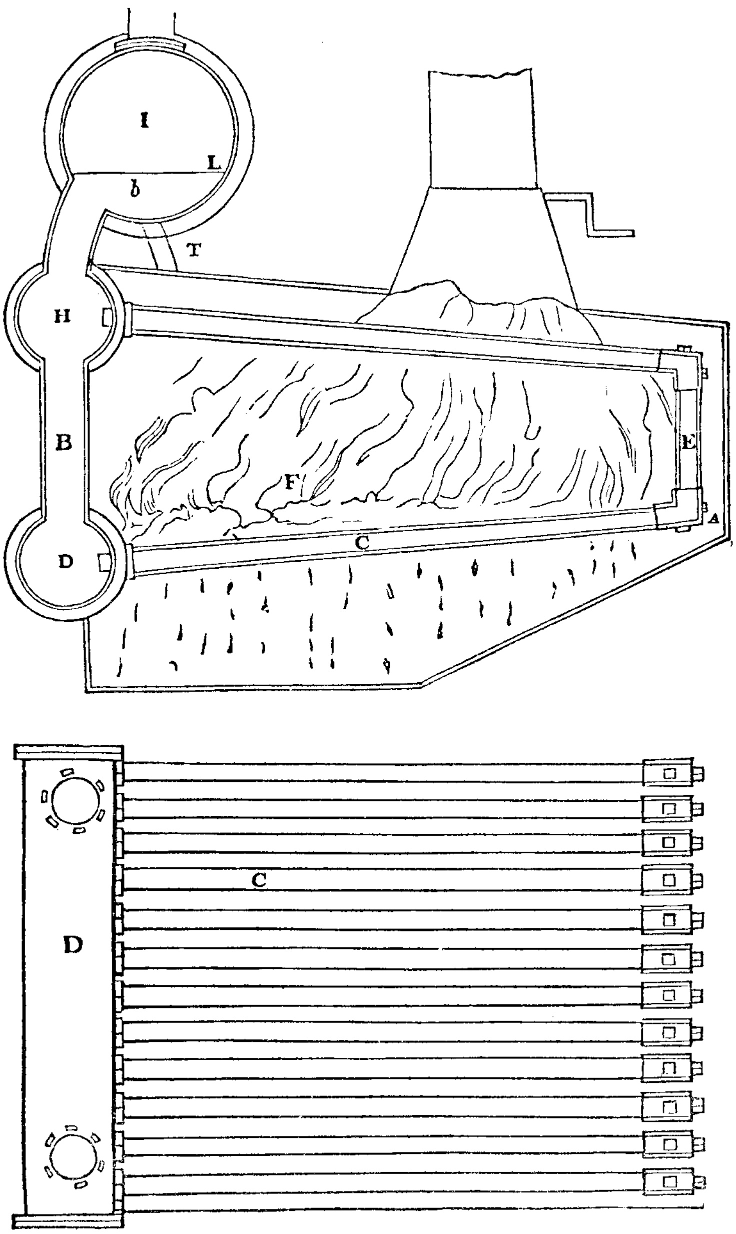
Though I speak without experience in this particular matter, I suggest that it might also be adapted to burn solid fuel by fitting a removable ashpan and an orthodox fire door. If its width is increased, a single blowlamp burner would not give sufficient volume of flame for efficient heating, and it would be advisable to use a twin burner; but an atomising burner could be arranged to produce a flattened, fanned-out flame which would adequately fill the furnace.

Additional to the boiler proper, I have shown a superheater consisting of a coil of $\frac{3}{16}$-in. tube, of not less than four turns, arranged above the generating elements, and brazed into the steam drum with an internal extension bent upwards to collect the steam from as high a point as possible; this should be near one end of the drum, and not immediately under the safety-valve, where it might be affected by the tendency of the water to "lift" when the latter is in action.

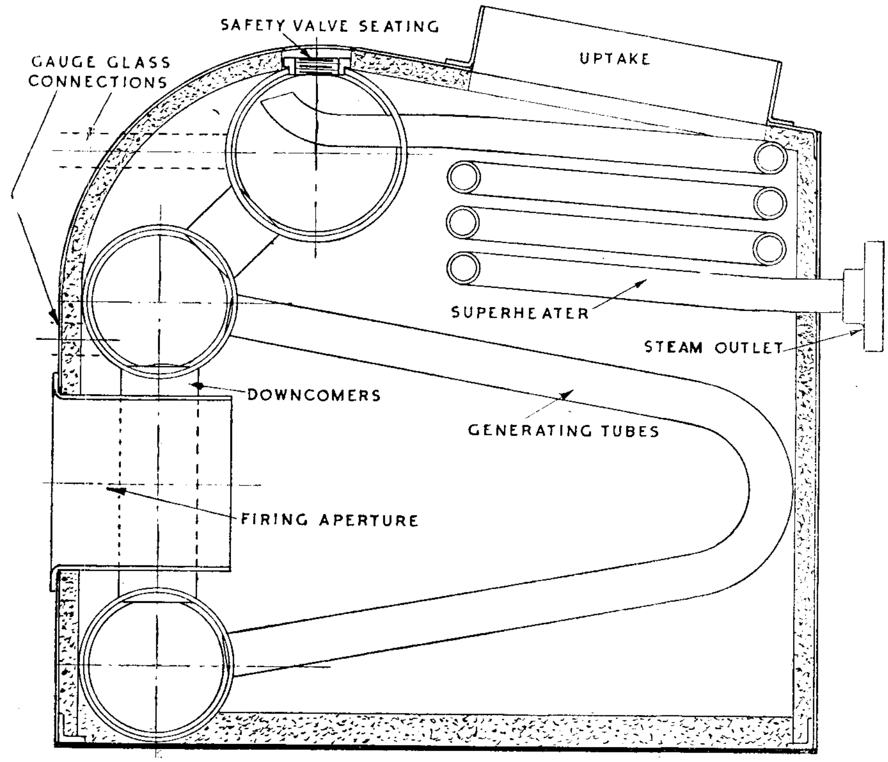
The communicating tubes from the upper water drum to the steam drum should be well out of line with the downcomers, to avoid similar interference effects. I have given the hairpin tubes a general gradient of about 10 deg., which is greater than that of the Gurney boiler, to give easier convection flow. The normal water level should be such as just about to fill the upper water drum.

Efficient internal lagging is essential in any water-tube boiler, and apart from fire-brick or fireclay linings, which are apt to be too fragile in the thicknesses which could be used for a model boiler, the most suitable material is asbestos millboard, which should not be less than $\frac{1}{8}$ in. thick. This material, if slightly damped, can readily be moulded to any shape, and if pulped with water, can be used as a plaster to fill cracks or build up irregular shapes.

The casing may be made of sheet steel, about 24 to 26 gauge, with flanged joints secured by light riveting. A plain rectangular casing would no doubt serve all practical purposes, but some attempt at shaping it to conform to the internal arrangement of the components is desirable, not only on the grounds of appearance, but also to keep it compact. The usual boiler fittings, including a gauge-glass (connected as indicated on the drawing), pressure gauge, quick-acting safety-valve, feed check (in lower drum) and last but not least, a blow-down valve, should be provided, at as low a level as possible, so that any suspended matter, or chemical impurities, can be cleared while the boiler is under steam. Water-tube boilers of any kind are particularly sensitive to feed-water pollution, and excessive salinity, acidity or alkalinity are equally harmful, being a prolific



The original boiler of the Goldsworthy Gurney steam carriage (1825)



Sectional side elevation of Gurney type model water-tube boiler

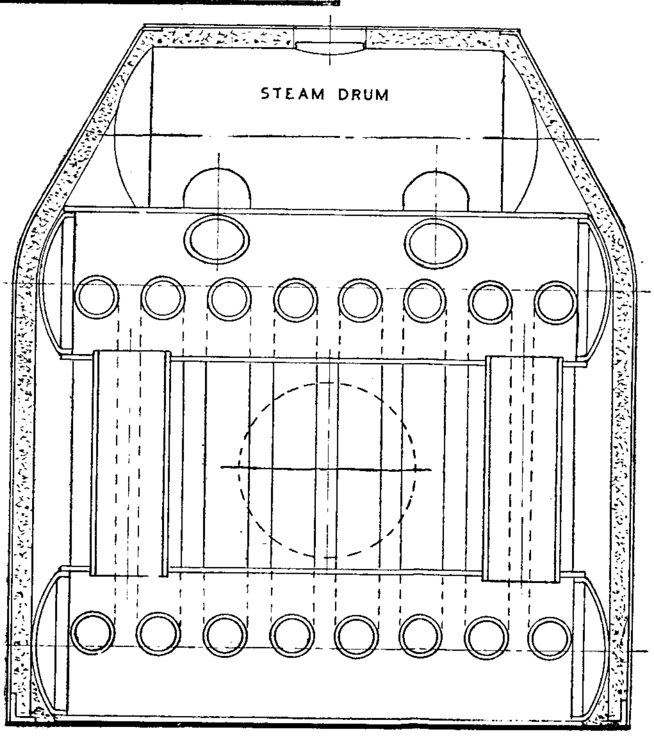
cause of priming when rapid steaming is attempted.

I once had the pleasure (?) of steaming a ship, the boilers of which had been damaged in a storm, which caused them to leak in various places, and soon used up all the reserve feed-water, so that sea water had to be taken in to replenish it. Even at greatly reduced speed, the priming was so bad that we expected the engine cylinders to disintegrate at any moment; the effect was as if someone was dumping cartloads of bricks into them ! One is inclined to wonder whether the usual practice of taking in pond water (some of it pretty murky !) to feed the boilers of model steamboats is not productive of more trouble than is commonly realised.

Construction

Although this boiler is more complicated than most of the types used for marine models, it is fairly straightforward to build, as very little shaping and form-bending is called for, and the usual fabrication by brazing or silver-soldering is suitable for all joints. The tubes should in all cases fit fairly tightly in reamed holes in the drums, and the endplates in the latter should be fitted last of all; they may be produced very conveniently by spinning in the lathe, using copper of the same gauge as the tubes which form the drums. As there are no very large pressure vessels, the relative strength of the boiler is high in relation to the thickness of material, and with 18-gauge for the drums and endplates, and 22-gauge for the tubes, it should be capable of working at 150 lb. per sq. in. I have not shown any end stays in the drums, but it is quite a good policy to fit them, if only

(*Continued on page* 714.)



End elevation, section on centre-line of water drums

Cast-Iron Sticks

By

H. H. Nicholls

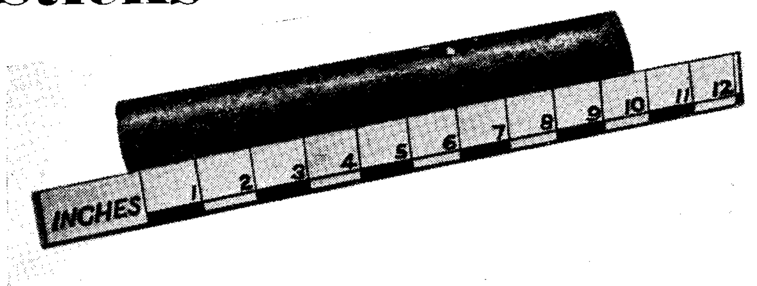


Fig. 1. A prepared piece of cast-iron stick

THAT cast-iron may be obtained in ready-cast sticks is a fact which may not be generally known.

The photograph Fig. 1, shows a piece of this material as prepared by the well-known firm, Messrs. Dick Simmonds & Co. of Erith, Kent.

To have cast-iron in this form is a very handy way to keep it in stock for small articles, and in a factory where the writer was employed during the war, the material was kept in stock for the turners working for the tool-room and in the maintenance shop; small circular articles such as spacing collars, bases for small tools, pinions, etc., were made quickly without any need for pattern-making or waiting for the foundry.

The amateur, the instrument-maker, and the laboratory mechanic will find this plan very useful on the smaller scale of their work; in the factory, the cast-iron round stock was kept up to 6 in. diameter, but 2 in. will be enough for a host of small jobs.

In Fig. 2, I show how a number of articles for entirely different applications may be made from one piece of stick; a clock weight, a pulley, a flywheel for a petrol engine, and a pinion blank. And bushes for bearings, made from cast-iron have a very long life in many applications; the irons having a high graphite content should be selected for this use. The writer strongly recommends that cast-iron in this form ought to be a part of the stock in a factory stockroom or in the model maker's cupboard.

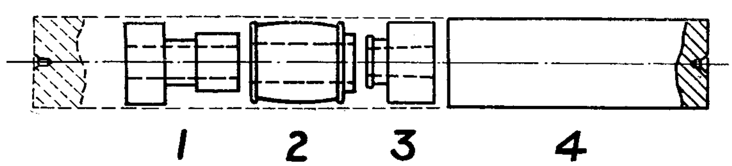


Fig. 2. Articles made from one stick of cast-iron: (1) *Special pinions, two in one blank.* (2) *Fan pulley.* (3) *Flywheel of petrol motor for model boat.* (4) *Clock weight*

And, of course, clock weights may be made without having to spend any time on patterns, a great advantage when one wants to get a job of restoration finished quickly.

Of this application, it must be said that care must be exercised, because if the weight is too large in diameter it will foul its neighbour if there are two or more in the case, while if too long, it may touch the bottom of the case and stop the clock. To find what mass is wanted, when weights have been lost, tie a bundle of metal to the line, or hook it on to the pulley, and add to or subtract from it until that train in the clock acts properly, then weigh the temporary weight and make the permanent one equal to this, observing the points previously mentioned.

Another application of the sticks of cast-iron is in making small pulleys and wheels for demonstration apparatus, etc., I show in Fig. 3, how these can be made in numbers from such a stick, in any capstan lathe, or an ordinary lathe, adapted with a suitable tool-holder, etc.

If one is using two tools for cutting off pulleys from a bar, the wider one will cut down as far as the boss, and the narrow one in the back tool-post will finish the operation. That part of the narrow tool which carries the cutting edge need only be long enough to reach into the bore of the pulley, its shank can be much thicker, taking advantage of the wide groove already cut—being careful, however, to see that the shank is not wide enough to bind against the flanges already cut by the front tool, as shown in Fig. 3.

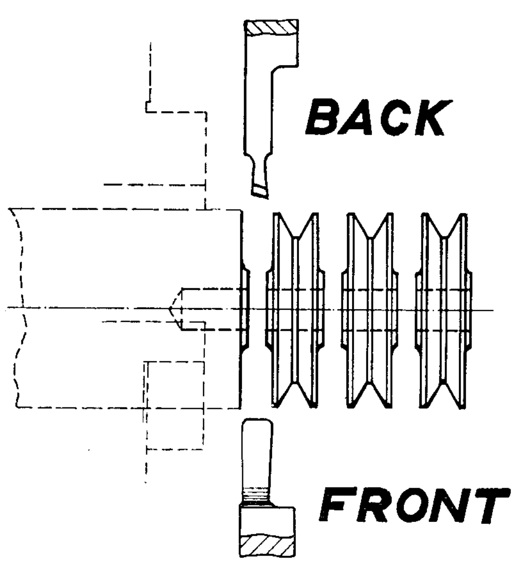


Fig. 3. Repetition parts made from cast-iron stick

READERS' LETTERS

● Letters of general interest on all subjects relating to model engineering are welcomed. A nom-de-plume may be used if desired, but the name and address of the sender must accompany the letter. The Managing Editor does not accept responsibility for the views expressed by correspondents.

TRACTION ENGINE DETAILS

DEAR SIR,—Re the recent letter about cross strakes on traction engine wheels and judging "M.E." exhibits, I would like to comment on a rather bald statement on page 11 of Mr. Hughes' excellent little book, *Traction Engines Worth Modelling* in which he states that he has seen two or three model engines with connecting-rods of rectangular section, but that he has never, never, seen them on the full size job.

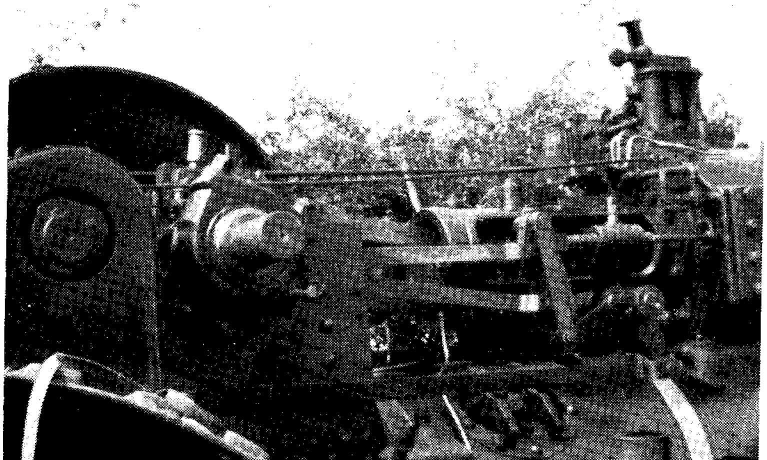
However, I am enclosing a close-up of the motion of a full size job with rectangular connecting-rods. This picture was taken in 1951, but I have seen the engine since then. She was certainly in existence in good condition as late as 1953, although I believe that she has since changed hands.

She is a Clayton & Shuttleworth compound 7 h.p. No. 47218, new in 1921, mounted on springs and she has a "Belpaire" type of outer firebox instead of the usual round-top boiler.

She was owned by Mr. C. Grice a farmer of Old Dalby, Leics. and was used for threshing work. If Mr. Hughes would like to get in touch with me, I have a few views of the engine from different angles and would gladly let him have them.

Yours faithfully,

Leicester. R. TAYLOR.



STEEL BOILERS AGAIN

DEAR SIR,—In a previous letter to you I advocated the use of steel for small locomotive boilers (of 5-in. gauge and upwards) in cases where it was not considered possible to build in copper, for one reason or another.

The recent articles by Messrs. M. E. White and J. Perrier have shown what is entailed in the building of copper boilers in the larger sizes by methods other than riveting-with-solder-caulking, and I am sure that there must be many who, like myself, whilst having been perfectly happy with the well-proven methods of "L.B.S.C." in producing reliable copper boilers in the $2\frac{1}{2}$-in. and $3\frac{1}{2}$-in. gauge sizes, feel that the brazing, or bronze-welding methods in these larger sizes are not quite our "cup of tea," quite apart from the costs involved. In the circumstances, therefore, an examination of the pros and cons of the welded steel boiler will be all the more closely followed.

In suggesting a steel boiler with copper tubes, I was advocating a method of construction brought to my notice some years ago by my friend and life-long model engineer, Mr. G. E. Read of North Reston, who has built several successful boilers this way, up to $1\frac{1}{2}$-in. scale on locomotive and a 3-in. scale traction engine, and in whose farm workshops I was able to arc-weld my own 5-in. gauge steel boiler.

The method, therefore, has proved to be quite satisfactory in practice, and in this connection I was interested to read the remarks of such an authority as "E.T.W." in your issue of April 29th, on the Blakeney test boiler of welded steel in the "M.E." workshop, though this article does not state whether the water tubes are of copper or steel.

I was aware of the probability of electrolytic action by using copper tubes in a steel shell, as pointed out by Mr. Daltry in his recent letter, but in spite of this I am still sure that copper is the better material for the tubes. For one thing, the local plumber stocks it, and is usually pleased to dispose of short scrap ends for the purpose. Fire tubes and superheater flue tubes for my boiler cost 13s. from this source, and I would still have been looking for steel tubes of the required size. Tube fitting by expanding is readily carried out with annealed copper tubes and one has the benefit of the higher conductivity when the boiler is in steam.

Examination of a table showing the electro-chemical properties of metals will reveal that steel has a lower galvano-anodic potential than copper, whilst aluminium is lower down the scale still.

With this in mind, I did consider the introduction of an aluminium rod to be screwed into the boiler shell at some convenient place below water level, as a sacrificial anode, capable of renewal at intervals; but in practice, after almost two years service, no such measure to counter electrolytic action has been found necessary—and this has been in the main in steaming with local tap water, an analysis of which shows it to tave a pH value of, approx. 7, i.e. neither acid nor alkaline.

From an electro-chemical aspect, the perfect boiler has still to be made, for what of the zinc content of some of the lower melting-point spelters used on copper boiler work, or the brass or gunmetal fittings used on steel boilers? Clearly, the elements are there for electrolytic destruction, but in practice, this

does not appear to be so serious as might be imagined, for the internal state of a small locomotive boiler after a few hours in steam differs greatly from test-tube-laboratory conditions, and the operative words of my previous letter—"given a light coating of internal scale," may well go some way to explaining this.

I am always reluctant to compare full-sized and small locomotive practice too freely—I have the greatest respect for the truth of the "L.B.S.C-ism" that "you can't scale nature"—but it is general British practice to build locomotive boilers with steel shells and copper firebox plates, and at Doncaster works in the days of my apprenticeship, it was usual to rivet these flanged copper plates together with steel rivets—the practice still prevails in many boilers, I believe.

In the Netherlands Railway workshops last year, I saw some beautiful examples of welded copper fireboxes, with flanged tube-plate and door sheet having a flame-welded butt-joint to sides and crown sheet, the whole firebox, thereby, being fused into a homogeneous copper unit. Steel tubes are general, though some builders braze a short length of copper tube to the end of the fire-tubes for insertion in the copper firebox tube plate.

Electric arc-welding has been employed in increasing extent on the steel plates of full-sized practice over the last decade or so. I remember seeing a batch of L.N.E.R. J.39 class boilers at Darlington works in the thirties with plain unflanged smokebox tube plates arc-welded into the front of the barrel, and at that time, this was thought to be quite revolutionary. Since then, of course, this method has been applied to other parts of the boiler's anatomy with apparent success.

To revert to our small locomotives, there appear to me to be several important points to emphasise concerning the steel boiler, viz: $\frac{1}{8}$-in. steel plate will be found stiffer to bend for elaborately shaped fireboxes than is the case with annealed copper and will really require oxy-acetylene to heat for bending. Therefore, best results will be obtained with the simple wide firebox "Atlantic" or "Pacific" boiler where the barrel and outer firebox can be made by the "tube-sawn-down-and-opened-out" method. It will be comparatively easy to weld extra plate to the sides if necessary to get the required depth.

This also applies to the 4-coupled and 6-coupled tank engine boilers, where the design can be simplified to give a plain rectangular firebox with round-topped outer casing, preferably sitting on top of the formes.

Belpaire boxes, taper barrels, etc., will entail considerably more thought and care (personally I would "mock" these features up if they could not be otherwise avoided).

I prefer to have all joints between copper and steel made mechanically, i.e., screwed, expanded or riveted.

I have not attempted the idea of a copper firebox in a steel shell for two main reasons: (1) I anticipate difficulty with the foundation-ring joint; (2) the staying of the copper firebox would have to be as complete as for an all-copper boiler.

My own boiler has an inner firebox of $\frac{1}{8}$-in. steel plate, stayed at the sides with $\frac{5}{16}$-in. B.S.F. high-tensile steel bolts, tapped through both plates and nutted on the inside of the firebox. The stay centres are $1\frac{3}{4}$-in. roof stays and are simply two pieces of 1-in angle-iron welded along the full length of the crown plate. The foundation ring is of $\frac{1}{2}$-in. round mild-steel—the vee so formed by using this cross-section being filled by welding on the firebox side on top and on both sides at the bottom. The tubeplates, door sheet and backhead are of $\frac{3}{16}$-in. plate. There are no flanged joints. All fittings are screwed 40 t.p.i. tapped straight into the steel plate. The boiler is unlagged and painted direct on the barrel, which is of steel tube approx. $\frac{3}{16}$ in. thick. Steam is raised from cold in average time of 10 min. and the boiler supplies ample steam for two $1\frac{1}{2}$ in. $\times$ $2\frac{1}{4}$ in. cylinders. Working pressure 90 lb./sq. in. It carries a periodic test pressure of 180 lb./sq. in. with satisfaction. The lower conductivity of steel may make steam raising somewhat slower —I cannot pass an opinion on this, however, not having been able to compare my boiler with a copper one identical in every respect; but I do know that once steam is raised, there is no difficulty whatever in maintaining ample pressure for all requirements. I have been so satisfied with this boiler that I am now building a larger one with wide firebox for a 5-in. gauge 2-8-2 which I have under construction. This will be some 30 in. long and $6\frac{1}{2}$ in. diameter, and the barrel is of steel tube $\frac{3}{16}$ in. thick of the type used by artesian-well borers. I shall fit a simple type of steel firebox with bent tube-plate to give greater length at top than at the bottom, and set the smokebox tubeplate back into the barrel some way to keep the tubes of reasonable length.

The steel boiler is heavy, but I like weight, for I am not tied to a maximum axle loading, and I don't like wheel slip ; 5-in. gauge, locomotives are not "one-man-loads" anyway !

I have handled an 0-4-0 "Midge" type tank locomotive on occasions, with a lovely copper boiler by Mr. Goodhand, and with this engine, the utmost care is required in firing, manipulating fire-door, feed-pump, etc., to prevent constant blowing off. Surely, therefore, some of the undoubted margin of conductivity and steam-generating capacity of the copper boiler may be forgone in view of the greater ease of construction in steel. I have gone to some length in setting out my experiences and ideas on this subject in the hope that they may be of some help to others, who, like Mr. W. Schutz in a recent issue of THE MODEL ENGINEER, are anxious to build a good "second best" boiler which will be of service on the larger sized locomotive.

Yours faithfully,

Louth, Lincs. JOHN R. BIRDETT.

Next Week . . .

REGATTAS

The annual regatta season has now begun, and the events at South London and St. Albans will be described in our Model Power Boat News feature.

THE "BUMBLE BEE"

Further particulars for the construction of this original and powerful little petrol engine, which is proving very popular.

AN INSPIRATION TO OTHERS

The story of two model locomotives and a "Busy Bee" cycle engine made by a young reader.

L.B.S.C.'s "TITFIELD THUNDER-BOLT"

The boilers for the various sizes of this engine having been described, the next components are essential for preventing explosions; i.e., safety-valves.

PRESSURE GAUGES

These desirable fittings for steam generators are not so very difficult to make; we shall provide the "know-how" next week.

A 150-YEAR-OLD RAILWAY

The Swansea & Mumbles Railway will be 150 years old on June 29th, an event that justifies the publication of details of its interesting history.

NEW VOLUME

Next week's issue will be the first of Volume 111.

QUERIES AND REPLIES

" THE M.E." FREE ADVICE SERVICE. Queries from readers on matters connected with model engineering are replied to by post as promptly as possible. If considered of general interest the query and reply may also be published on this page. The following rules must, however, be complied with:

(1) Queries must be of a practical nature on subjects within the scope of this journal.
(2) Only queries which admit of a reasonably brief reply can be dealt with.
(3) Queries should not be sent under the same cover as any other communication.
(4) Queries involving the buying, selling, or valuation of models or equipment, or hypothetical queries such as examination questions, cannot be answered.
(5) A stamped addressed envelope must accompany each query.
(6) Envelopes must be marked " Query " and be addressed to THE MODEL ENGINEER, 19-20, Noel Street, London, W.1.

Motor for Stage Curtain

I propose to apply electric drive to a small stage curtain having a span of about 20 ft. Can you please advise me of a suitable type of motor to run on 250-volt single-phase a.c., easily reversible by switching, and variable speed by rheostat if possible?

Can such a motor be obtained cheaply on the surplus market? If not, please advise me of a supplier of a new motor.

D.R. (Radcliffe).

We are of the opinion that a motor of about ¼ h.p. would give ample power for the purpose you require.

The normal type of single-phase alternating current motor to work on the 230 volt 50 cycle mains would be suitable for this duty, working at a constant speed, and is easily reversible by switching. It is not, however, capable of speed control, as it will only run at a speed somewhere in the region of synchronous speed, that is to say, 1,500 r.p.m. for a 4-pole motor, which, allowing for a certain amount of slip, under load, works out at 1,425-50 r.p.m.

If you require a variable speed motor, we suggest that a motor of the Universal series-wound type would be more suitable, though it is possible to obtain a certain amount of speed regulation on a repulsion-induction type of a.c. motor by shifting the position of the brushes.

We do not know of any motors suitable for your purpose that are obtainable at present on the surplus market. Either of the types described above can be obtained from the well-known manufacturers of motors, but we cannot advise you of the cost.

Lubricant for Tapping

I have occasion to tap a considerable number of holes in 10-B.A., in various depths to about ⅜ in., in mild-steel, but have been unable to avoid breaking several taps in the process. I have used a No. 54 drill, with a plentiful supply of machine oil as a tapping lubricant. The threads have also not been as clean as I should have liked. Can you help me to get better results, please?

A.L. (Ripon.)

Although almost universally used by the amateur and professional alike, ordinary machine oil is a very poor lubricant indeed for tapping purposes, and a series of tests carried out with various lubricants has shown some surprising results. The power required for tapping being expressed as a percentage of the breaking strain of the tap, it was found that, using ordinary machine oil, the power required was about 34 per cent. of breaking strain, while a power of only 16 per cent. was required when using animal lard oil. A mixture of one part graphite to 9 parts tallow gave a figure of only about 17 per cent. Ordinary soap gave a figure of around 20 per cent.

It would be quite safe to increase the drill size to No. 53, which, in conjunction with one of the above lubricants, should cure your trouble.

Lathe Drilling Out of Truth

When drilling holes of any considerable depth, using the lathe tailstock, I am troubled by the drills wandering, so that the resultant hole is out of line. Can you tell me how to cure this, please?

H.K. (Poole).

Any of the following causes may account for your difficulty:—

(1) Tailstock out of line with the headstock.

(2) Drill chuck out of truth.

(3) Uneven grinding of the drill point; i.e., unequal lengths of drill flats, so that the point of the drill is off-set; the angle of one flat differing from the other, so that one side of the drill tends to cut more than the other. Unequal backing-off angles on the flats.

(4) Failure to withdraw the drill from the work to clear the chips, so that the flutes become packed.

(5) Forcing the drill instead of allowing it to cut at its natural rate.

(6) Insufficient drilling speed, especially with small drills.

Numbers (2), (3) and (6) are the most probable.

Boiler Design and Construction

(*Continued from page* 710)

because the extended ends can be employed usefully to fix the boiler in its casing. Brass rods ⅛ in. diameter, screwed Whitworth or 5 B.A. on each end, are suitable for the stays.

Steam Car Construction

Following my recent observations on steam cars, I have received a good deal of correspondence on this subject, and have seen the progress made in power plant development by the British Light Steam Power Society, including a d.a. compound engine, donkey pump, and monotube boiler made by one of the members.

Mr. J. Walton, former secretary of this society, of Kirk Michael, Isle of Man, has submitted for my inspection a set of drawings for a light steam car power unit, suitable for converting existing cars, such as the Morris " 8 " or Ford Anglia, to steam power. It is designed to utilise the existing chassis, final drive, and rear axle, but the clutch and gearbox are, of course, dispensed with, as the engine can be direct-coupled to the transmission shaft.

A forced circulation boiler, capable of raising steam in less than three minutes, is employed, fired by paraffin with an atomising burner of the carburettor type, with electric ignition, and automatic temperature and pressure control. The overall size of the plant is as follows: Height, 1 ft. 3 in.; length 2 ft. 6 in.; width, 1 ft. 8 in. In all, the set comprises 37 sheets of drawings, which are moderately priced in view of the amount of detail they contain. These and several other drawings of steam car engines, boilers and burners, can be obtained from Mr. Walton at the above address.

(*To be continued*)